consulting engineer

UNIV. OF MICHIGAN
MAY 6 1953
ENGINEERING

Parking Problem Solved
Spray Deaerators
Tubular Bus Structure
Economics of Power Generation
Industrial Site Drainage
Ventilating Indian Steam Plant
New Precipitators
Elevators—Old and New
Fighting Underground Fires

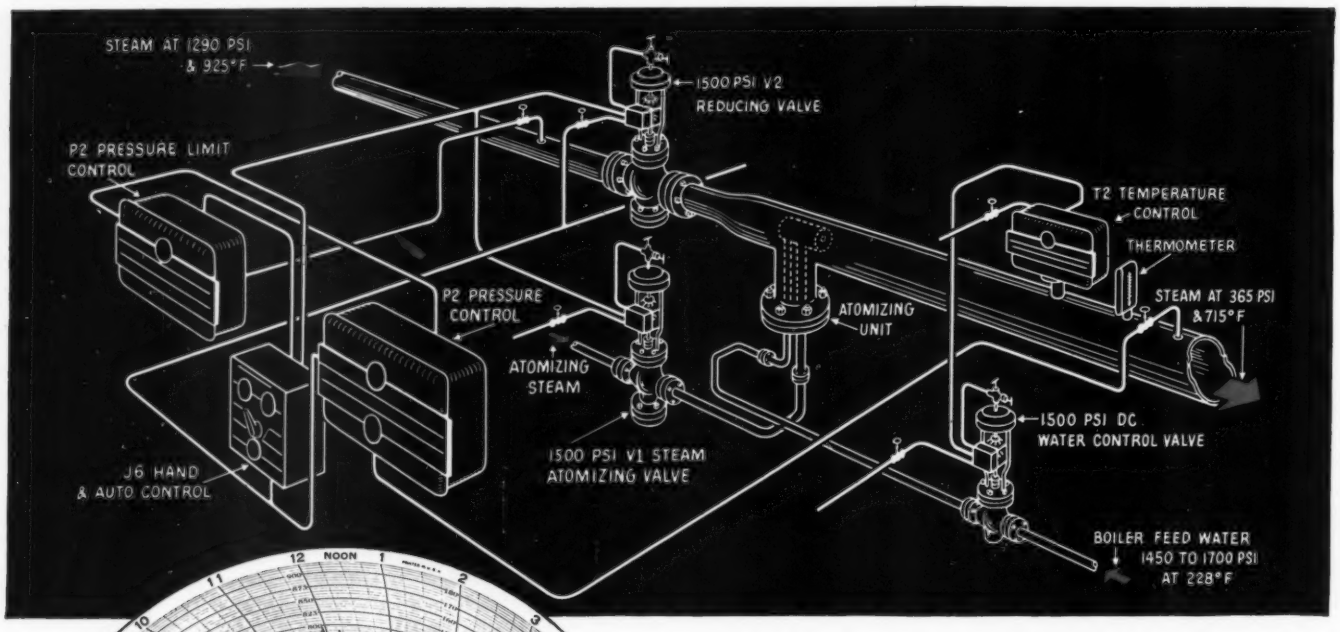
Ten Million Kilowatts
or Twenty Fish in Twenty Minutes

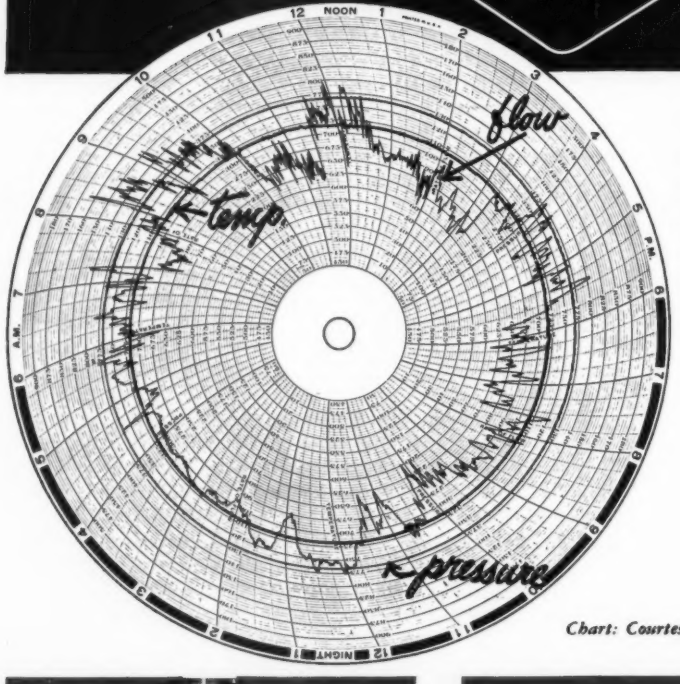
Before H. L. Melvin went to Greece in 1949, most Greeks thought Ebasco was a hot sauce used to pep-up *pizza Napolitana.* Melvin changed this. Not only do the Greeks know Melvin, but they know he is Chief Consulting Engineer of Ebasco Services, Incorporated, for his most recent major project has

(Continued on page 9)

March 1953

Swartwout RDC* controls within ±1 psi and ±3°F even with widely fluctuating load swings


STEAM AT 1290 PSI & 925°F
1500 PSI V2 REDUCING VALVE
P2 PRESSURE LIMIT CONTROL
T2 TEMPERATURE CONTROL
THERMOMETER
P2 PRESSURE CONTROL
ATOMIZING UNIT
STEAM AT 365 PSI & 715°F
ATOMIZING STEAM
1500 PSI DC WATER CONTROL VALVE
1500 PSI V1 STEAM ATOMIZING VALVE
J6 HAND & AUTO CONTROL
BOILER FEED WATER 1450 TO 1700 PSI AT 228°F

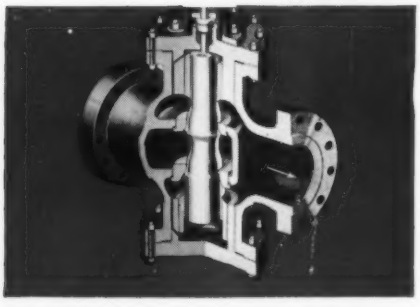


1 Chart shows how Swartwout RDC*—Reducing, Desuperheating and Control System—handles low-pressure turbine load of 65,000 to 165,000 lbs. steam per hour in Des Moines Power Station No. 2 of the Iowa Power and Light Company. It reduces from 1290 to 365 psi and desuperheats from 925° to 715°F. When main reducing valve closes, extremely light loads can be handled by pressure reducing valve supplying atomizing steam. Operation of the system is stable regardless of load change or time lag. Because of the exceptional control obtained by this large station, the Iowa Power and Light Company later purchased an additional small Swartwout RDC unit to supply steam to house turbines.

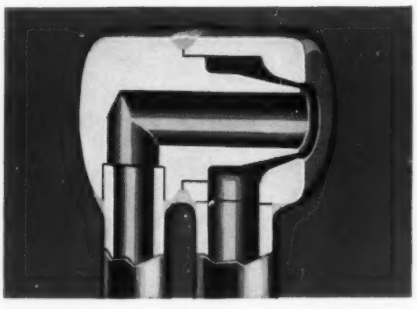
Swartwout

POWER PLANT EQUIPMENT

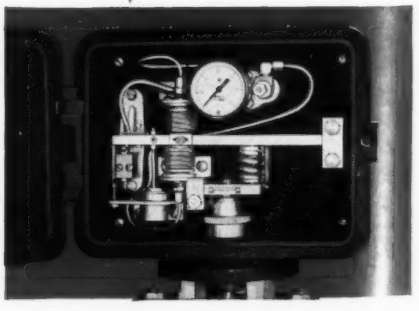
Chart: Courtesy Iowa Power and Light Company



2 Swartwout V-2 Regulating Valve has smooth, nozzle-shaped passages which guide expansion of high-pressure steam to reduced pressure zone without high-velocity impingement or other destructive forces common to conventional valves. Undue noise, turbulence and vibration are eliminated; longer valve life results.



3 Swartwout Steam Atomizing Desuperheater, constructed of stainless steel, has accurately machined passages that give narrow-angle dispersion of cooling water outside of steam atomizing head. There is no impingement of steam or water against walls of unit, no erosion of parts, no need for pipe liners.



4 Swartwout T-2 Control, with met llic temperature element in steam p pe, gives rapid and precise control regar ess of magnitude of load or time lag. Ther are no flapper valves, relays or other del ate elements. Only two simple adjustm nts are involved; one for temperature, one for response.

-3692

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VOLUME 2
NUMBER 1

consulting engineer

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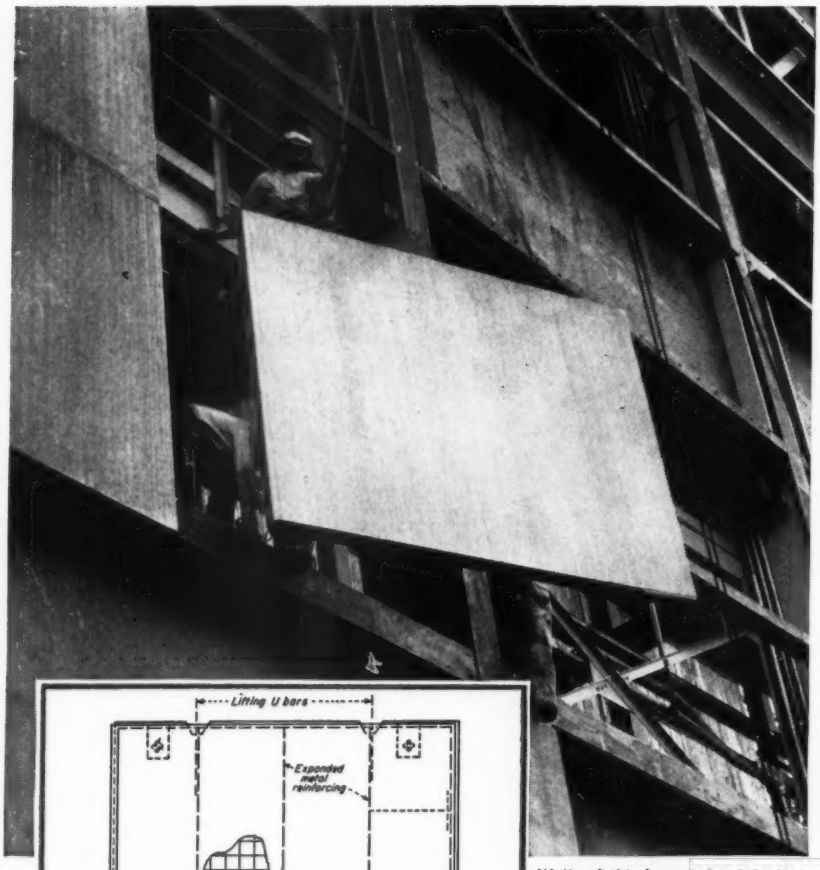

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3,000 SQ. FT. OF FINISHED WALL IN A DAY!

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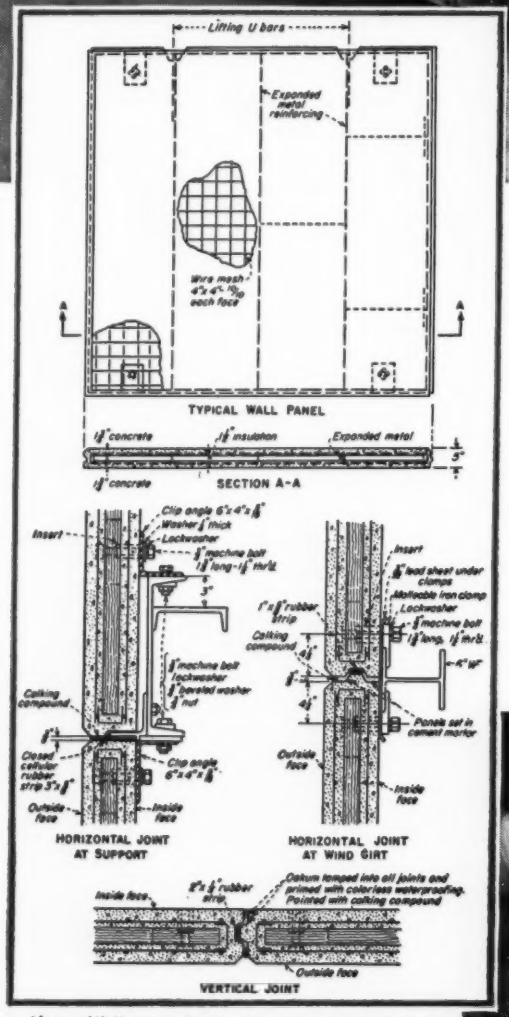
with MARIETTA precast, concrete insulated wall panels!

Walls of this huge industrial plant were erected at the rate of five 8' x 10' panels an hour, at a completed wall cost of approximately $2.25 to $2.50 per sq. ft. Cost varies slightly depending on shipping distance from plants, standardization in panel sizes, etc.



Above: Wall panel details show panel construction and method of joining slabs. Courtesy of Ford, Bacon & Davis, Inc.

Whatever the weather—cold or hot, wet or dry—you can start that new plant, now, and finish it ahead of schedule, with MARIETTA "sandwich" wall panels . . . and trim costs as much as 30% under comparable masonry construction! Yes, these large, easy to handle panels actually cut labor and application time . . . close in large areas quickly . . . bolt directly to building framework and go up in half the time required to erect conventional walls.

MARIETTA panels consist of two layers of reinforced concrete separated by rigid insulation . . . concrete tests 4,300 psi in 7 days . . . although only 5 inches in thickness, they give an insulating (U-value) of 0.14 compared with .36 for 12" of brick. Panels have uniform appearance and pre-finished exterior and interior surfaces.

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Let our Engineering Department help you speed the construction of your next building and cut labor costs. They'll supervise the design, production and erection of MARIETTA precast, concrete insulated wall panels specifically developed for your needs. Write now for their help.

At right: Panels are cast solid or with insulation in a variety of sizes. They can be trucked to your building site directly from our plants in Marietta, Ohio, and Baltimore, Md., or cast at your site if it is beyond favorable shipping distances.

THE MARIETTA CONCRETE CORP.
MARIETTA, OHIO

Very Truly Yours

Miss B . . . , my attractive and efficient secretary, opened the door to my office one morning early in December.

"Chief", she said, "I still have the feeling that something is missing."

"Ugh," I muttered. "Why this 'Chief' business." Then looking Miss B. . . squarely in the eye and touching my brow to see that my headdress was properly adjusted, I asked in a clear and authoritative voice, "What's missing?"

"An Editor," said Miss B. . . , "an Editor-in-Chief. Every magazine needs an Editor-in-Chief."

"Ugh!" I said, a sudden look of understanding crossing my open, honest face. "It just could be, Miss B. . . , there is some logic in your suggestion. I, too, had a feeling something was missing. Yes, you are right, a magazine should have an editor, and I, as General Manager—", and here I dropped my hand from my brow and watched it fall into the paste pot on my desk—"I, as General Manager, should not have to sit here day after day licking paste from my fingers. A General Manager, Miss B. . . , is an executive, not a paste taster."

In just such an inauspicious manner, the search for an Editor was begun. I spent the Holidays reading applications from the most amazingly capable men. Finally, I found the very man Miss B. . . must have had in mind. Instead of being an engineer who happens to be able to edit, he is an editor who happens to be an engineer. That is what we think a good engineering magazine needs.

Hunter Hughes, Editor of CONSULTING ENGINEER, has spent the last twelve years editing engineering magazines. He is a graduate mechanical engineer from a school he calls "The University" (for the benefit of non-Virginians, that means the University of Virginia), where he founded and edited *The Virginia Engineering Review* as an undergraduate.

Moving even further south, he helped edit *Southern Power And Industry,* first in Atlanta and then the Dallas office. Later he was Associate Editor of *Textile Industries,* the largest technical magazine in that field.

Located in Rock Hill, South Carolina, he was active in the affairs of both technical societies and civic clubs. Last year he was chairman of the Piedmont-Carolina Section, of the American Society of Mechanical Engineers. He founded the Rock Hill Engineers Club, and was President of the local Exchange Club.

We had to promise to import a full year's supply of grits before he would even consider moving north.

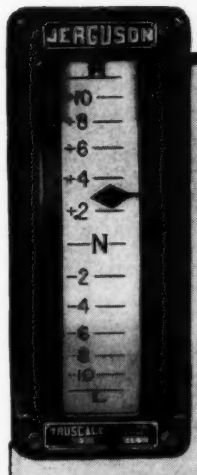
We think Hunter Hughes will do a sound job of technical editing. Being an engineer he knows what engineers want in their magazine. Being an editor, he knows how to present it to them.

Last week Miss B. . . moved the paste pot from my desk to his.

"Good morning, Mr. Hughes." said Miss B. . . , presenting him with the tools of his trade.

"Ugh," Hughes replied, adjusting his headdress.

Very truly yours,
Monte Sanders, General Manager



Assures Positive Distance Reading of Liquid Levels

JERGUSON TRUSCALE GAGE

THE modern design JERGUSON TRUSCALE GAGE gives new accuracy for reading of liquid levels in boilers, deaerating tanks, etc.

Here is the remote reading gage which incorporates all of the newest engineering features! The Jerguson Truscale has exceptional sensitivity, with ability to register changes as small as ½ of 1% of range! The translucent dial scale is clearly lighted from behind, and is easy to read.

Available with positive alarm system. Lights and horn signal too high or too low water level.

Visible Alarm

Horn

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Available with Repeaters which repeat accurate level readings at auxiliary locations.

Marine Operators: *Special installation procedure compensates for roll and pitch of your ship.*

Write for Truscale Catalog

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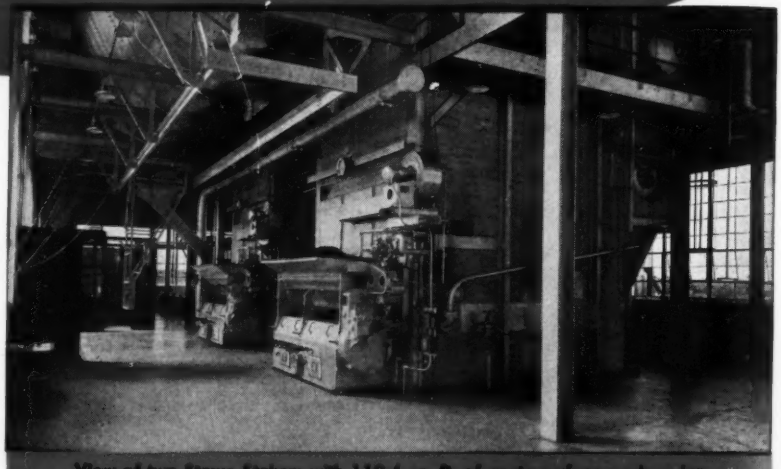
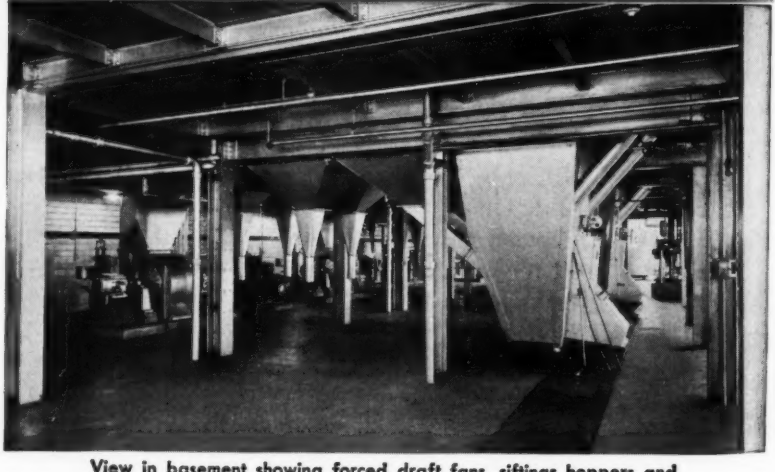
STOWE Stoker

HANDLES LOAD SWINGS OF *16* TO *1*
without losing ignition... without smoking and without exposing the grates



View of two Stowe Stokers with 110.4 sq. ft. of grate surface each under Wickes 3 drum low head boilers rated at 35,000 lbs./hr. each.



View in basement showing forced draft fans, siftings hoppers and dust tight ash removal system.

• In winter, the heating load usually results in **High Load** operation, emphasizing one group of advantages resulting from Stowe Stoker's unusual design.

And in the summer time — the absence of a heating load underscores Stowe Stoker's unique ability to operate efficiently at **Low Loads,** very important to plants handling ***both*** a heating; ***and*** a power or service requirement.

The Stowe Stoker installation pictured at the right handles load swings from

40 lbs. of Coal/sq. ft. of Grate/Hour
Maximum Condition
to
2.5 lbs. of Coal/sq. ft. of Grate/Hour
Minimum Condition

under automatic control — without loss of ignition — without smoking — without exposing the grates — and without any other firing problems.

Our Catalog 501 describes the unusual, "only one of its kind" design that enables Stowe Stokers to handle peak loads without "balling up" the fire, and minimum loads without loss of ignition. Write for a copy!

What Stowe Stokers are doing for others— They can also do for you!

STOWE Stokers

Manufactured by THE JOHNSTON & JENNINGS CO. • 6917 Bessemer Avenue • Cleveland 27, Ohio
.... *Division of* PETTIBONE MULLIKEN CORP...

Ten Million Kilowatts — H. L. Melvin

(Continued from front cover)

been the development of a modern power system for their country.

To Melvin's way of thinking, this is a particularly interesting job because it involves building a complete electric power system, practically from scratch, to utilize Greece's own lignite and hydro resources, thus freeing them to a considerable degree from their past dependence upon imported fuel oil.

Electric service, even in Athens, is still very limited, but when the power system now under construction is completed, a foundation will be laid for one of the most modern systems in the world.

Melvin liked that job, for to him there is no satisfaction so great as that of seeing an electric power system grow from an engineering conception to a successful operation. In the forty-one years since he received his first engineering degree from Washington State College, he has had several occasions when he could look with pride upon his part in the fulfillment of just such projects.

H. L. Melvin went with Electric Bond and Share (one time parent company of Ebasco) in 1925. His first assignment was the development of the present Middle South Utility system. He has seen this company grow from a capacity of less than 100,000 kw to the 1,500,000 kw of today.

After graduation from Washington State, he was in General Electric Company's Testing Dept. for one year, followed by four years at his alma mater as instructor in Electrical Engineering.

In 1916-17 he did graduate work at Massachusetts Institute of Technology, receiving a Master's Degree from MIT and Harvard University. It was in 1917 that he started his career in the utility business as assistant electrical engineer with the Utah Power & Light Co. on transmission design and technical and system operating problems.

In 1920 he transferred to Spokane to be assistant and then electrical engineer for The Washington Water Power Co. during a major hydro plant and transmission line expansion program. Since 1925, in the Ebasco organization, he has occupied positions of electrical engineer, general engineer, consulting general engineer, and chief consulting engineer.

His experience with Ebasco has been primarily in the field of high voltage transmission and the planning of systems from distribution to power resources. In the eleven years that he has been chief consulting engineer, he has supervised the planning of system expansion projects covering approximately 10 million kilowatts of thermal and hydro capacity, with associated transmission and distribution facilities for about 30 operating utilities in the United States and foreign countries. Consultation on the organization and operation of power pools is a specialty, the Northwest Power Pool being a notable example.

Melvin would be the first to admit that as much as he loves his work, there have been times when he considered giving it all up. His greatest temptation to retire came the day he was fishing in Jerry Creek in Montana, when he pulled in twenty trout in twenty minutes. A far-away look came into his eyes when he landed his first salmon—a fifteen pounder with a six inch fly rod. That was on the Tabusintac River in New Brunswick. And while he is loyal to the golf course at Upper Montclair, he had to admit that it does not, in his opinion, quite come up to the Glen Eagle course in Scotland—again comes that far-away look.

It does not take long, though, for Melvin to be back on the subject of power systems. "What we need now," he says, "is planning. The whole utility industry must work closer together. They must coordinate their efforts. We must be ready to meet the tremendous electric demands of the future."

A good idea, Mr. Melvin, and with your help. . . . .

YOUR TECHNICAL LIBRARY

Every good engineer wants to build a technical library of his own. Most never get around to it . . . too busy, too many other things on his mind. CE has worked out a plan with the publishers of technical books so that you can build your library with the very minimum of effort. See page 88.

EXTRA YEARS

OF MORE DEPENDABLE POWER

and at less cost per pound of steam

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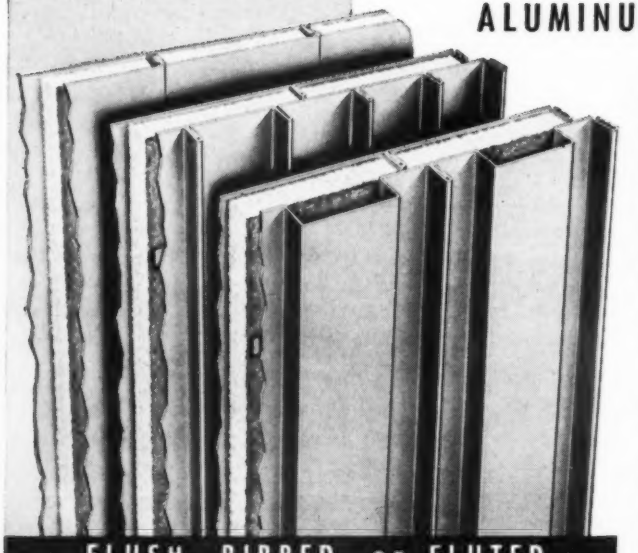

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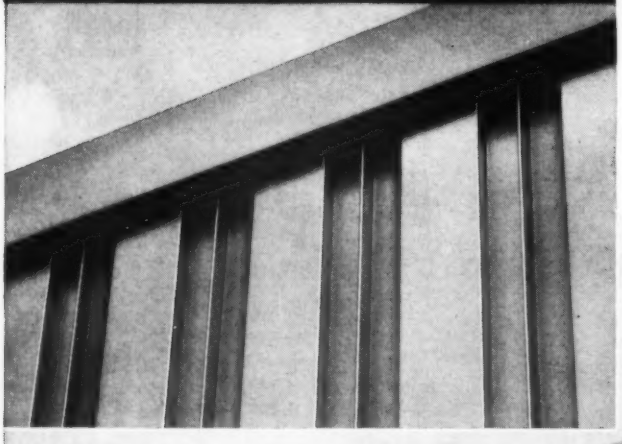
Over-all "U" Factor of Various Types is Equivalent to or Better than Conventional 16" Masonry Wall



Today, Insulated Metal Walls are saving construction dollars in both material and labor costs . . . they are reducing construction time through rapid erection—even in periods of extremely low temperature. This amazingly light weight construction, with an over-all "U" Factor superior to a conventional masonry wall, permits further economies in the building frame or supporting structure. Architects, as well as owners and management groups throughout the country are revising their concept of permanent exterior wall construction. In the powerhouse illustrated below, Mahon Fluted Type, Field Constructed Insulated Metal Walls with galvanized steel exterior plates were employed to good advantage for virtually all exterior walls. Mahon Insulated Metal Walls are available in the three exterior patterns shown at left . . . each lends itself to individual architectural expression in building design. The Mahon "Field Constructed" Fluted or Ribbed Wall can be erected up to sixty feet in height without horizontal joints—a feature of Mahon Walls which is particularly desirable in powerhouses, steam plants, warehouses, auditoriums, or other buildings where high expanses of unbroken wall surface are common. See Sweet's Files for complete information including Specifications, or write for Catalog No. B-53-B.

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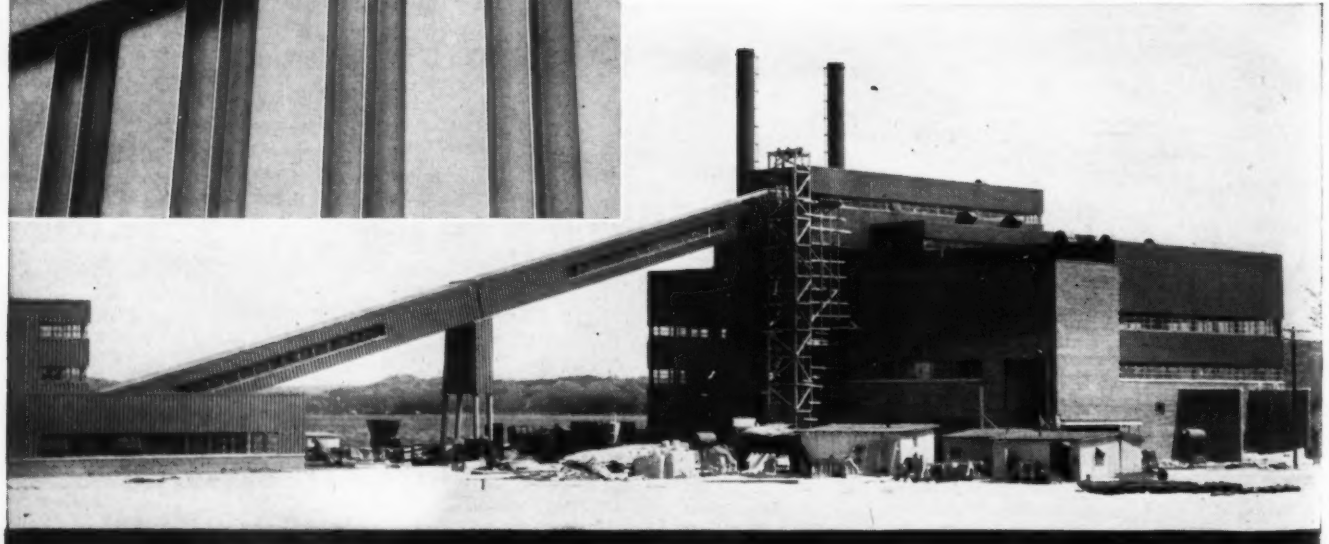
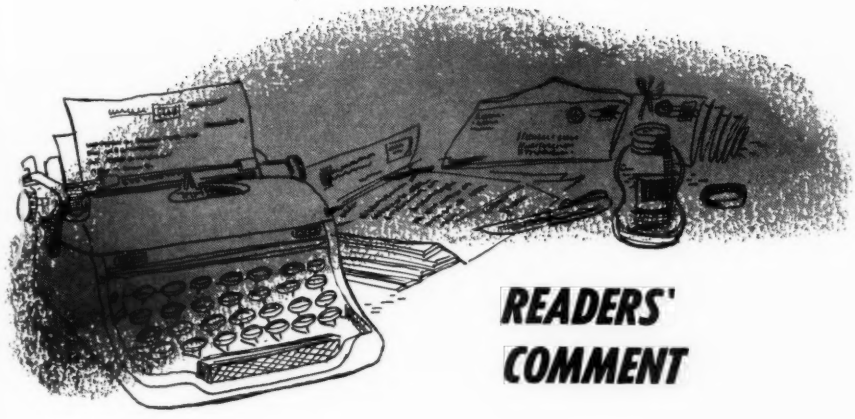
Detroit 34, Mich. • Chicago 4, Ill. • Representatives in all Principal Cities

Manufacturers of Insulated Metal Walls; Steel Deck for Roofs, Partitions, and Permanent Concrete Floor Forms; Rolling Steel Doors, Grilles and Underwriters' Labeled Rolling Steel Doors and Fire Shutters.



MAHON



READERS' COMMENT

Our Broad Viewpoint

Sir: . . . I have read the first issue of CONSULTING ENGINEER with a great deal of interest and wish to take this opportunity to congratulate you on filling a need which as of this date has not been filled . . .

I am particularly impressed with the broad scope of the articles and of the magazine, and by the fact that the articles are written from the general viewpoint which is of particular interest to engineers operating in a management capacity. May I also comment on the fact that a number of your articles have specific information insofar as costs are concerned, which data generally is very meagerly given in technical publications.

A. Wilson Knecht
Seelye Stevenson Value & Knecht
New York

Our Narrow Viewpoint

Sir: . . . Being in the consulting engineering field, I find that the magazine, although well prepared and edited, is devoted predominantly to the fields of mechanical, electrical, industrial and power engineering. I am not sure whether it is your intention that the publication cover equally well all fields of consulting engineering or whether it is designed primarily to cover the aforementioned fields. If the former is true, I would suggest a better rounded coverage of all aspects of consulting engineering.

Arthur C. Miller
Vice-President
Michael Baker, Jr., Inc.
Jackson, Miss.

Swain's Law

Sir: . . . I shall be in a better position to praise the general overall value of CONSULTING ENGINEER when I have seen a few more issues. What I have seen so far impresses me as excellent.

One element of considerable value lies in keeping a consultant in one field acquainted with the problems in nearby fields. A consultant cannot afford to be quite as much of a specialist as can the pure scientist, or rather I should say, he should be just as much of a specialist in his own field but he cannot afford to ignore the fields which border upon his own.

In glancing over the article entitled: "The Hidden Floor", I was reminded of comments which I invented sometime ago . . . having to do with space and the characteristics of personnel to expand all over any space available. The comments were founded upon the physicist's definition of a gas. . .

"An number of physicists, no matter how small, will fill any space, however large, to which they may be assigned.

"Under these conditions, the volume of the physicists can only be reduced by the application of pressure.

"The application of said pressure is accompanied by the generation of much heat, which can only be dissipated by providing work for the physicists to do."

W. F. G. Swain, Director
Bartol Research Foundation of
The Franklin Institute
Swathmore, Pa.

● SOME CAN OPERATE IN A VACUUM-ED

Civil War

Sir: . . . Our compliments on a well published periodical of very obvious need and worth.

A careful reading of the magazine and a study of the advertisements has brought forth again that old division of engineering. . . . those of the engineering profession engaged in power, process, construction, and steam are considered engineers, and those employed in the engineering of 'means of production' are considered designers, . . . or inventors . . . This division in the engineering profession is not condusive to harmony, accord, and solidarity so desperately needed today among all engineers.

You can, with the means now available to you in CONSULTING ENGINEER, help to heal this schism. CONSULTING ENGINEER can bring forth in articles, editorials, and technical reports the functions and values of this [means of production] section of engineering.

J. A. Idank, Chief Engineer
Special Devices Division
The Parco Company, Inc.
New York

The General

Sir: . . . I have read this magazine with considerable interest . . . I have long felt that the engineering profession would profit by a magazine of this character which would maintain a very high quality . . .in the articles presented. If you can continue on this basis and select topics which are of general interest to the consulting engineer, I think you will have a successful publication.

A. M. Kinney, President
A. M. Kinney, Inc.
Cincinnati, Ohio

The Specific

Sir: . . . Since the term "consulting engineer" takes in so many different activities in the engineering line, I am wondering what your program is for covering the field sufficiently to interest men in the various divisions of the profession. For instance, our business is concerned almost exclusively with the coal mining and salt industries in all of their various branches. We naturally would be interested in something that pertains to our work in reading your publication.

William von Meding, President
Allen & Garcia Company
Chicago, Ill.

Power Factor Correction

Sir: . . . As the firm of Alan Porter Lee Associates is engaged primarily in the processing of edible oil, from the seed stage to the end products of cooking oils, shortening and margarine, there are very few phases of engineering with which we are not associated.

The writer found the articles entitled "Economics of Power Factor Correction" and "Project Planning on a Turn-Key Basis" . . . of special interest. I feel that the context of the magazine in general is excellent and that if your future issues continue to have comprehensive articles by specialists in various phases of engineering, it will become in a very

What's New IN BOILER

Yarway Remote Liquid Level Indicator, manometric type, with automatic temperature compensation.

IMPROVED *WIDE VISION* REMOTE LIQUID LEVEL INDICATOR

A new-type face on the Yarway Remote Liquid Level Indicator now permits side as well as head-on dial readings. This vastly improved visibility makes it possible to check boiler water levels from most any position in the control room, or wherever the Yarway Remote Indicator may be installed.

MANOMETRIC TYPE

The Yarway Indicator is a manometric type with automatic temperature compensation. Level readings are instant and accurate because the indicator is operated by the boiler water itself. The indicating mechanism is never under pressure. There are no stuffing boxes.

Over 8,000 Yarway Remote Liquid Level Indicators are successfully operating throughout industry—primarily for indicating boiler water levels, but also for many other liquid level applications, and for superheater pressure differential indication aboard ship.

For full information on Yarway Indicators, write for Yarway Bulletin WG-1823.

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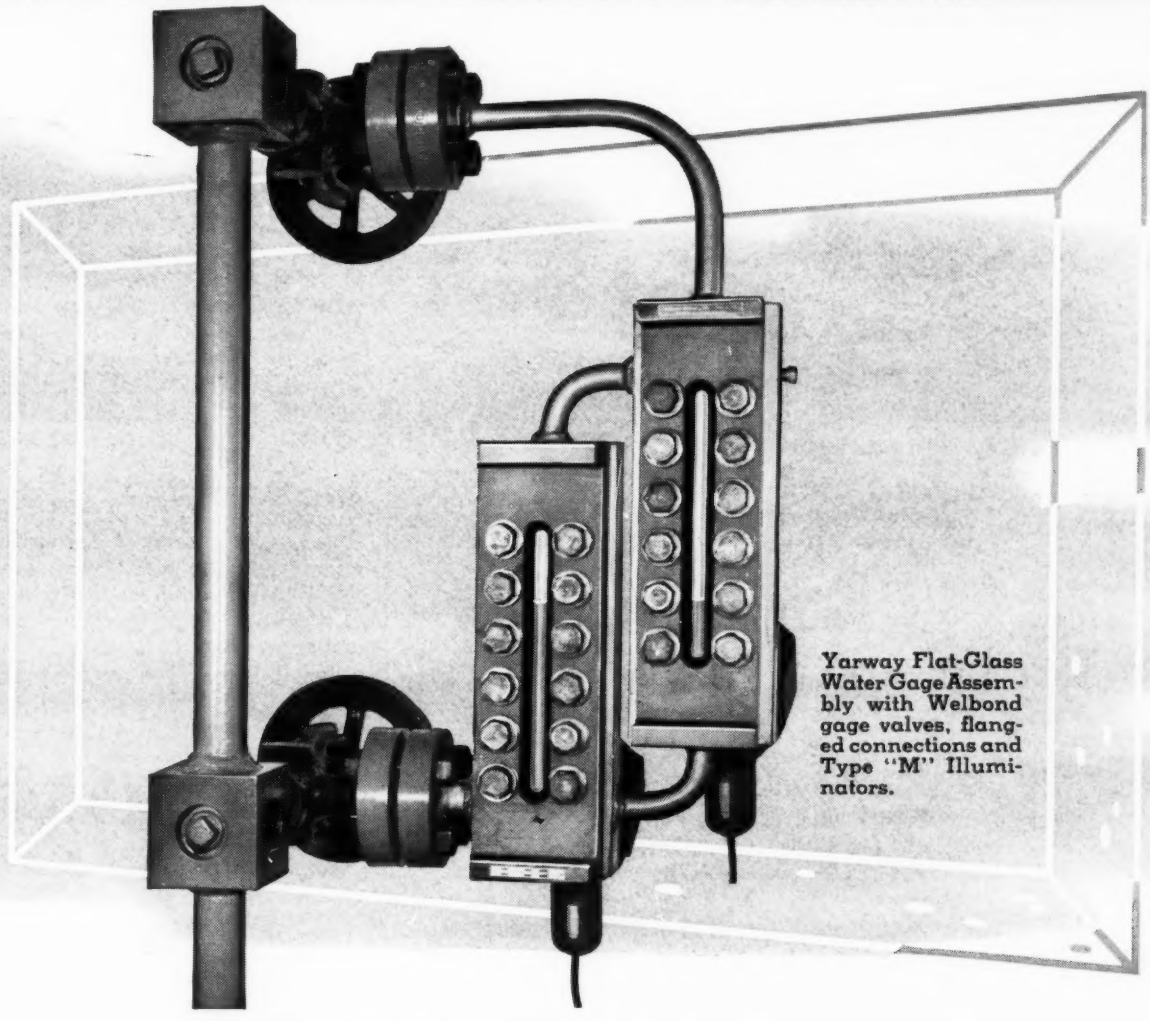
WATER LEVEL INDICATION?



Yarway Flat-Glass Water Gage Assembly with Welbond gage valves, flanged connections and Type "M" Illuminators.

NEW *SEPARATED-DESIGN* WATER GAGES

This new Yarway water gage assembly has been developed to meet the demands for greater dependability, longer life, and more accurate readings in high pressure service.

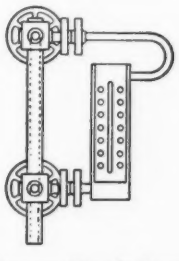
The gage glass inserts are of the Yarway pressure-sealed "floating assembly type". Yarway Welbond gage valves are used. Greater flexibility is gained by using two independent inserts, and by interconnecting expansion loops (see above).

The short connection to the drum assures greater accuracy of the gage reading, and the lower flanged connection eliminates a stuffing box. The upper flanged loop connection between the insert and gage valve allows expansion and contraction of the various components.

The tie bar-type water column linking the gage valves provides circulation to keep gage nearer drum temperature.

Yarway Type "M" Illuminators on the gage inserts cause the meniscus at water level to "shine like a star". This illuminator is especially effective in penetrating deposits on gage glass, dust particles in air and extraneous light.

For full information, write for Yarway Bulletin WG-1811.



Yarway Single Insert type gage for medium range of visibilities.

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an AMERICAN *first!*

The *first* and *only*

ELECTRO MAGNETIC CHEMICAL FEEDER

to give you infinite increment control

Mathematical accuracy—not guesswork—enables you to determine the exact chemical dosage with the Electro-Magnetic Proportioner, the heart of all AMERICAN Chemical Feeders . . . No other chemical proportioner on the market can compare with it for *accuracy, simplicity, durability* or *dependability! Unconditionally guaranteed for Five Years!*

Infinite pawl engagement—another AMERICAN exclusive!—assures you of positive stepless control. Vernier adjustment gives you micrometer control over chemical feed. Frequent impulses actuate a powerful solenoid entirely encased in a bronze housing and all working parts run in oil. All swing-pipe joints are positively non-binding.

AMERICAN Chemical Feeders offer you better continuity—with impulses every 15 seconds or less . . . American Chemical Feeders are built to last—and they do! Some have given satisfactory service for more than a quarter-century!

The AMERICAN Electro-Magnetic Proportioner has wide application as the basic unit on all lime-soda softeners—cold or hot process. Any water-treating plant can take advantage of its accurate, automatic proportioning of chemicals. It is often used to modernize old plants, as well as to solve problems in new plants.

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READERS' COMMENT

(Continued)

short time a periodical highly regarded by the professional engineer.

O. Robert Koenig
Alan Porter Lee Associates
Morristown, N.J.

Sir: . . . The first article "Economics of Power Factor Correction" covers a subject on which I am working at the present time, and I have enjoyed reading it and checking over the points raised . . . The news item relative to the formation of the Ohio Valley Electric Corporation . . . it is of great interest. I will look for further information on the construction described as work progresses.

M. Dwight Bell
Professional Engineer
Minneapolis, Minn.

All Around Lockwood Greene

Sir: . . . This issue has been passed around among our various engineers who would be interested in it, and all of them have expressed their appreciation of the articles and data contained therein. We think you have done an excellent job in providing information. . .

William J. Heiser
Lockwood Greene Engineers, Inc.
New York

Talk from Texas

Sir: . . . It is the candid opinion of this writer that if the December issue is a criterion of future publications, you are off to a flying start in fulfillment and realization of your editorial aim in supplying a technical magazine catering principally to the problems of the consulting engineering profession.

Henry J. Johnson
Consulting Engineer
Houston, Texas

Forced Circulation

Sir: . . . A few of the men in the office have picked up the magazine from my desk and commented on what a fine magazine it is and wanted to know where I had obtained it. I will see that it is circulated throughout the office.

E. R. Shequine
Combustion Engineering — Superheater, Inc.
New York

Professional Standing

Sir: . . . . . want to congratulate you for the splendid publication you pre-

READERS' COMMENT

(Continued)

pared. But more than that, you are to be commended for the thought that led to the creation of this magazine. Too often, not only in the past but in the present as well, a consulting engineer failed to achieve the recognition he rightly deserved as a professional man because of the association in the public's mind of the engineer with the jack-boot, rod-carrying individual commonly portrayed. And not less frequently has he had to hear other callings, such as accountancy or nursing, designated as professions, all the while knowing that of all professions, with the possible exception of medicine, none requires more intensive training, and longer apprenticeship than the practice of consulting engineering. . . . I feel that your publication is the best attempt thus far presented to accord to engineers the dignity and status long overdue.

Alfred J. Kleinberger
Consulting Engineer
New York

Sir: . . . The engineering profession is just about where the medical profession was at the turn of the century. You may recall that doctors of different training could not practice in each others hospitals . . . The engineer has just, within the last fifteen years, become recognized and admitted to practice by law in the various states. The professional consultant badly needs the continued public selling of the profession. . . . would help if a regular part of the magazine [were to] pound and pound and pound to sell the standing of the profession.

G. H. Kendall
Mechanical Engineer
Darien, Connecticut

CONSULTING ENGINEER

welcomes letters from readers. We will publish letters discussing the pro's and con's of any engineering topic. This Department is an open forum for consulting engineers. It will reflect the moods and opinions of the engineering fraternity. We will also welcome criticism of the magazine and its readers' services.

The Editors

This little Allen wrench **plus**.....

Quikupl®

SAVED US 37% ON PIPING INSTALLATION COSTS

SAYS
CHARLES VOJIK
ASSISTANT SUPERINTENDENT
NEWS SYNDICATE CO., INC.

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BULLETIN Q100

Get the full story of this amazing stainless steel fitting which permits quick assembly and disassembly of stainless pipes or tubing without threading, flaring or welding.

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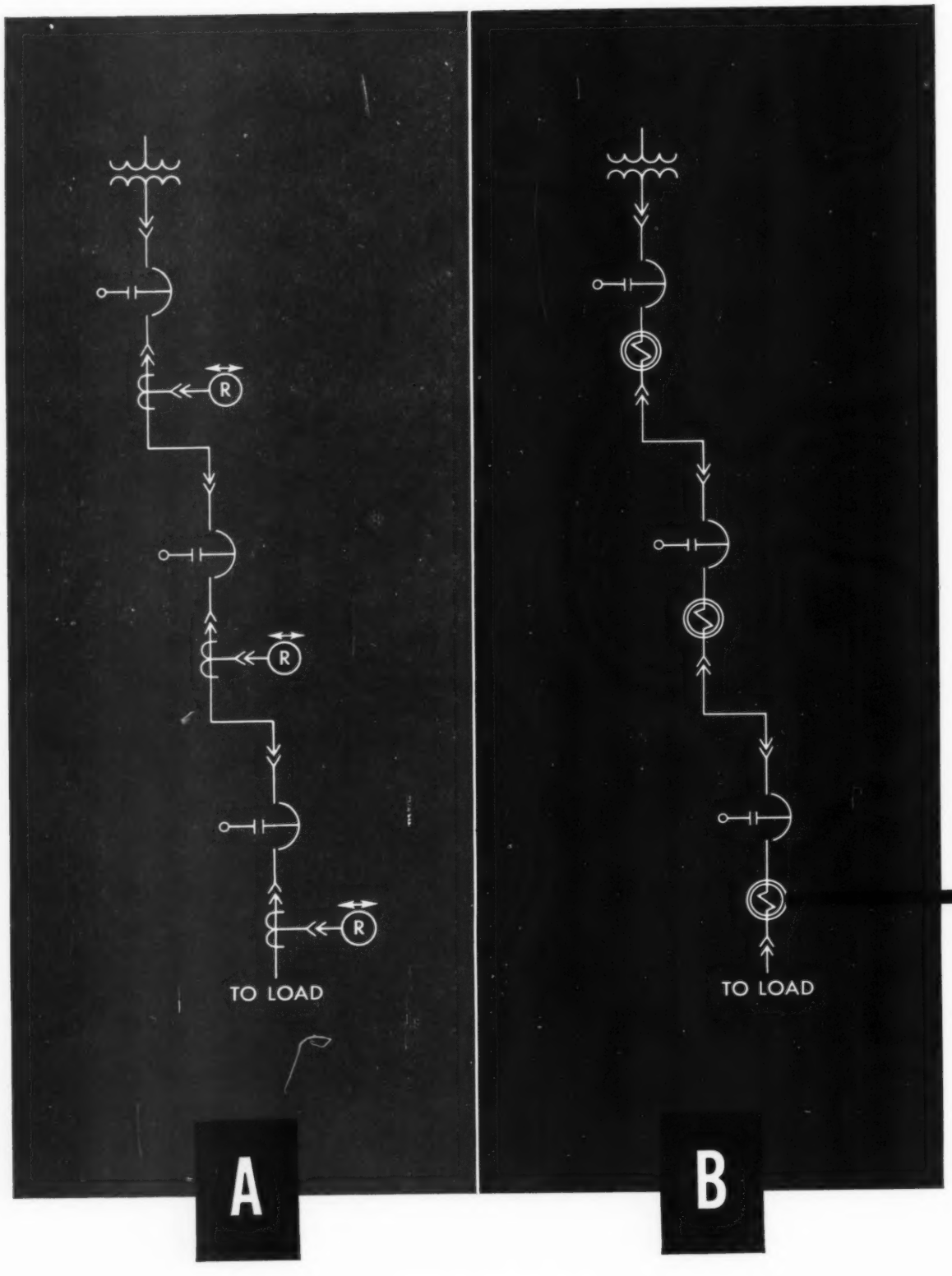

selective trip circuit breaker protection

but this *direct-acting* device on I-T-E circuit breakers cuts initial cost and saves space

These two systems were designed to perform identical functions. System **(A)** is costlier, takes more space, and requires a greater degree of skill to maintain.

System **(B)** represents the latest thinking in low-voltage system reliability and introduces the use of I-T-E circuit breakers with direct-acting dual-selective overcurrent trip devices. Savings in initial investment, in space, and in over-all maintenance are achieved.

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Let's assume you're a Conveyor-Project Engineer employed by Hapman —

QUESTION 1—Which materials in panel would you advise can be efficiently handled by Hapman Tubular Sealed-pin Chain Conveyors?

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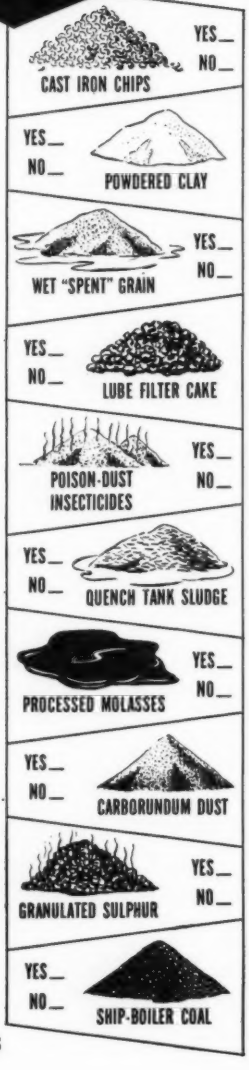
3 H.P.____ 5 H.P.____

QUESTION 3—A prospect asks, "What is the *outstanding* advantage of a Hapman Tubular Conveyor?" What's your reply?

ANSWERS: 1—All now successfully handled except sticky molasses. 2—One horsepower. 3—Hard to answer. In one case, ability to convey *wet* material is vital; in another the Hapman's air-tight seal keeps moisture or dust *out*—or fumes *in*. Ability to curve around obstacles may be essential. Your best answer: "They cut costs!"



NOW SEND YOUR QUESTIONS!

Write for details and Bulletin CE-353

Hapman CONVEYORS, INC.
DIVISION HAPMAN-DUTTON COMPANY
KALAMAZOO MICHIGAN

Scraps & Shavings

SYLVANIA SAYS their Dr. George Morrison can use radioactivity methods to measure impurities of one part in 100 million in germanium. This approaches the sensitivity of the female eye, which will detect a millemicron of strange face powder on a husband's lapel.

AMERICAN PIPELINERS, it says in a news release, are behind a proposal to build a gas main over 2500 miles long from the Red Sea, along the southern coast of the Mediterranean, under Gibraltar, over the Pyrenees, and then under the Channel to London. It would be a handy means of getting British diplomats home from nationalized oil fields in the Near East.

SEVERAL BREWERS are using a tiny crystal of cadmium sulfide and an 80,000 v x-ray tube to inspect cans and cartons. This equipment will inspect 900 containers per minute with an accuracy of plus-or-minus 30 drops of beer. We can probably look forward to beer advertised, as, "The radio-active brew with that cadmium sulfide flavor".

A NEW FIELD is now open for Sunday newspaper travel editors. They can secure good positions writing employment ads for engineers. A quick glance at the latest issue of *Mechanical Engineer* shows the type of copy being used to induce engineers to take a job. "Both cities (Seattle or Wichita) provide fine fishing, hunting, golf, boating." "Suburban Living? It's here—within easy driving distance of your work. Within a few minutes of shopping centers . . . schools . . . metropolitan centers." "Albuquerque lies at the foot of the Sandia Mountains which rise to 11,000 feet . . . scenic beauty . . . sunny, mild, dry . . . year 'round sports." Then, too, there are "paid vacations, complete employee service program, cost of living bonus, six paid holidays, group insurance, transportation and moving allowance, and educational refund program." We are not complaining, you understand, but when *we* got out of school . . .

PRESIDENTS OF LARGE CORPORATIONS are beginning to understand the importance of new employee induction programs, according to a recent news bulletin. They are "making it a point to shake hands and say a few words to all new white-collarites (sic) hired". That's going right far. After all, they will have to go through all that again when they give out the gold watches on the "white-collarites" twenty-fifth anniversary.

A 40 TON TRAINLOAD of German steel crossed tariff-free into France early in February, the first steel shipment under the Schuman plan treaty. This is unquestionably better than the Franco-German system previously used of trading tariff-free steel over trenches every twenty years.

Economic News Notes —

E. F. Mac Donald
INDUSTRIAL ECONOMIST

ENGINEERS' UNIONS. Growth of engineering unions in aircraft companies on the West Coast may be leading a national trend, according to R. Wilkens, Manager of Industrial Relations at Consolidated Vultee. Speaking to a meeting of the AMA General Management Conference, he suggested that management might keep engineers out of the union parade by giving them the feeling that they are part of the management. He contended that communications between management and engineers have been "very sad."

ATOMIC ENERGY. How atomic power can be put to work in the factory will be on the agenda of the American Management Assoc. spring conference at the Hotel Statler, New York City, April 8-10. Applications of radioactive isotopes to every-day quality control, testing, inspection, tracng, and production problems will be described, with opportunity for questions on specific company problems.

SYNTHETIC RUBBER PLANTS. The RFC has recommended to the President and Congress that the 28 synthetic rubber plants under its control be sold to private industry on a negotiated basis rather than by sealed competitive bidding. The President must submit a disposal plan for the facilities to Capitol Hill by April 15. Congress will have the final word on how the $500 million of plants will be sold.

NAVAL PROCUREMENT. To expedite procurement processes, the Navy signed its first "basic agreement" contract last month. The new agreements are aimed at eliminating pages of "boilerplate" and "fine print" and at saving time and paper. The agreement does not constitute a contract, but is a master agreement on general provisions to be included in all future contracts, leaving only matters of quantities, prices, specifications, and delivery dates for later contracts. The new procurement method may be adopted permanently following evaluation.

PUBLIC WORKS. President Eisenhower has called for a "strong Federal program" in the field of natural resources, suggesting also that it be used as a pump-primer in case of a business slump. There does not seem to be any thought of taking government out of the power business or of curtailing planned projects. However, states and communities will be brought into the picture on a "partnership" basis, and overlapping Federal activities in power and flood control projects will be narrowed down.

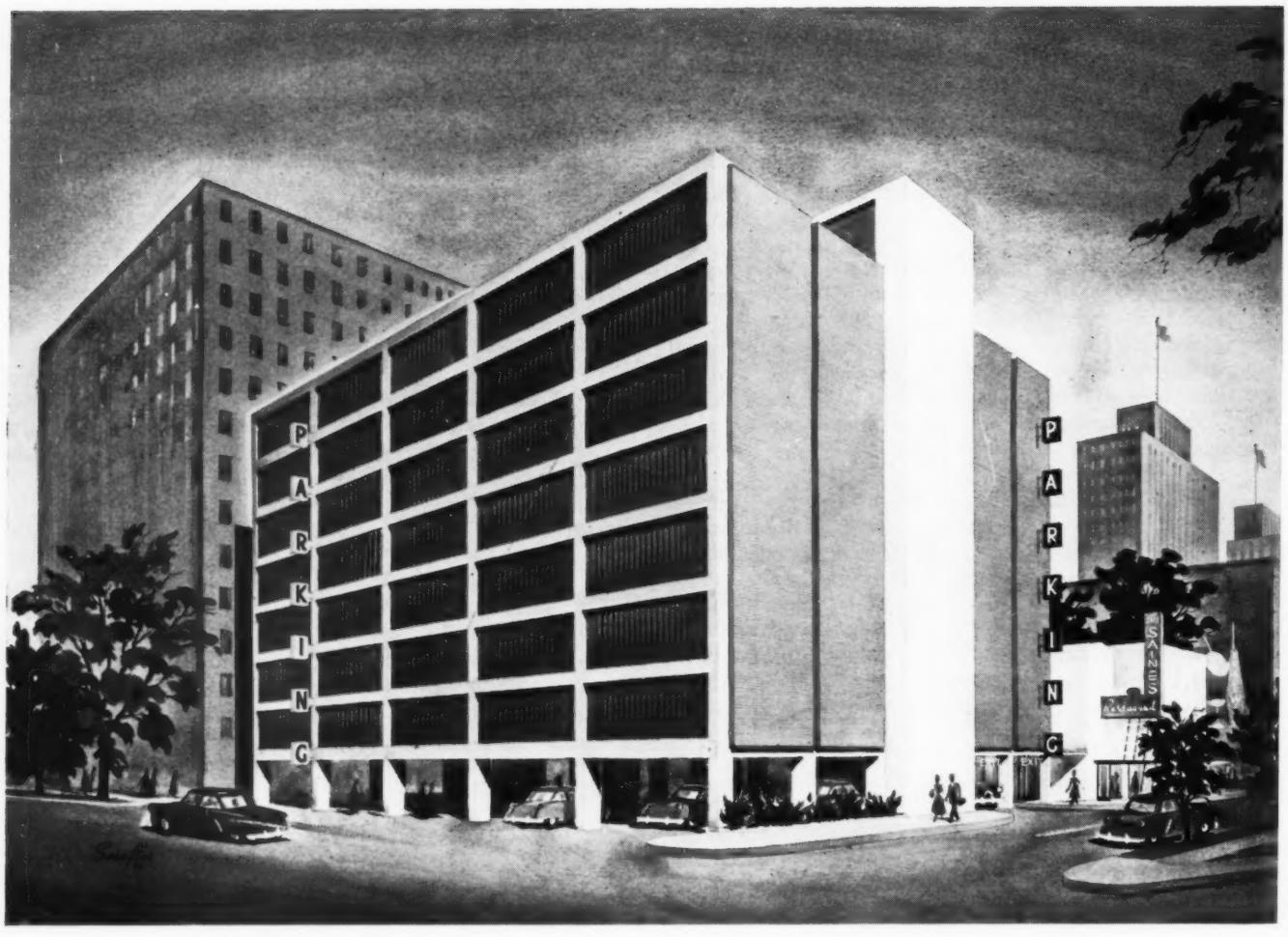
HIGHWAY FINANCING. Opponents of diversion of highway tax revenues had their innings at the meeting of the American Road Builders Assoc. in Boston last month. The Federal government and the 26 states that divert highway tax revenues to other than highway uses were prime targets. Senator Edward Martin, Chairman of the Senate Public Works Committee, stated, " . . . no part of the gasoline taxes should be diverted into the general fund, and the Federal government should withdraw from the field of gasoline taxation as soon as may be consistent with the needs of national defense." The meeting discussed also the shortage of engineers, said to be worse in the highway field than in any other because of inadequate salary levels.

COMMERCE PREDICTS. Total construction this year, according to Department of Commerce estimates, will amount to $33.5 billion, up 4% from 1952. Private construction put in place should gain 2.4%, and public construction should rise 6%. Commerce looks for the big increase in private construction to occur in commercial building, 27%, and the big drop in industrial building, 28%. Private housing put in place should increase almost 4%, and public utility construction should record a 11% gain.

STRONG STEEL DEMAND. Receipts of new orders against 2nd quarter allotments ran well above earlier expectations. Principal steel products with all the earmarks of being in tight supply through the first half include hot and cold rolled sheets, structural shapes, sheared plates, carbon bars and pipe. Open-ending of CMP will have little effect on steel supplies this first six months since there are enough CMP tickets outstanding to absorb total output of all major items. The key to the demand situation beyond the first half might well lie in the success with which auto manufacturers realize present production goals.

SPOTLIGHT ON SCRAP. Decontrolled iron and steel scrap prices are being watched closely by steel consumers for indications of subsequent movements in finished steel markets. Now that the scrap market has been freed, it is expected to demonstrate again its old "forecasting" characteristic. The best guesses now of what will happen to steel prices when they are decontrolled is that price adjustments will be selective and, for the most part, restrained.

BASING POINT AGAIN? Senator Capehart predicts that Congress will pass a law this year reviving the basing point system of determining prices, ruled out by the Supreme Court in 1948. "You can't deny the right to firms to equalize, absorb or pay for the freight on their products," he stated to a news conference. The system of absorbing freight charges had been used by the steel, cement and other heavy commodity businesses to meet competition of rivals producing goods at or near distant markets.



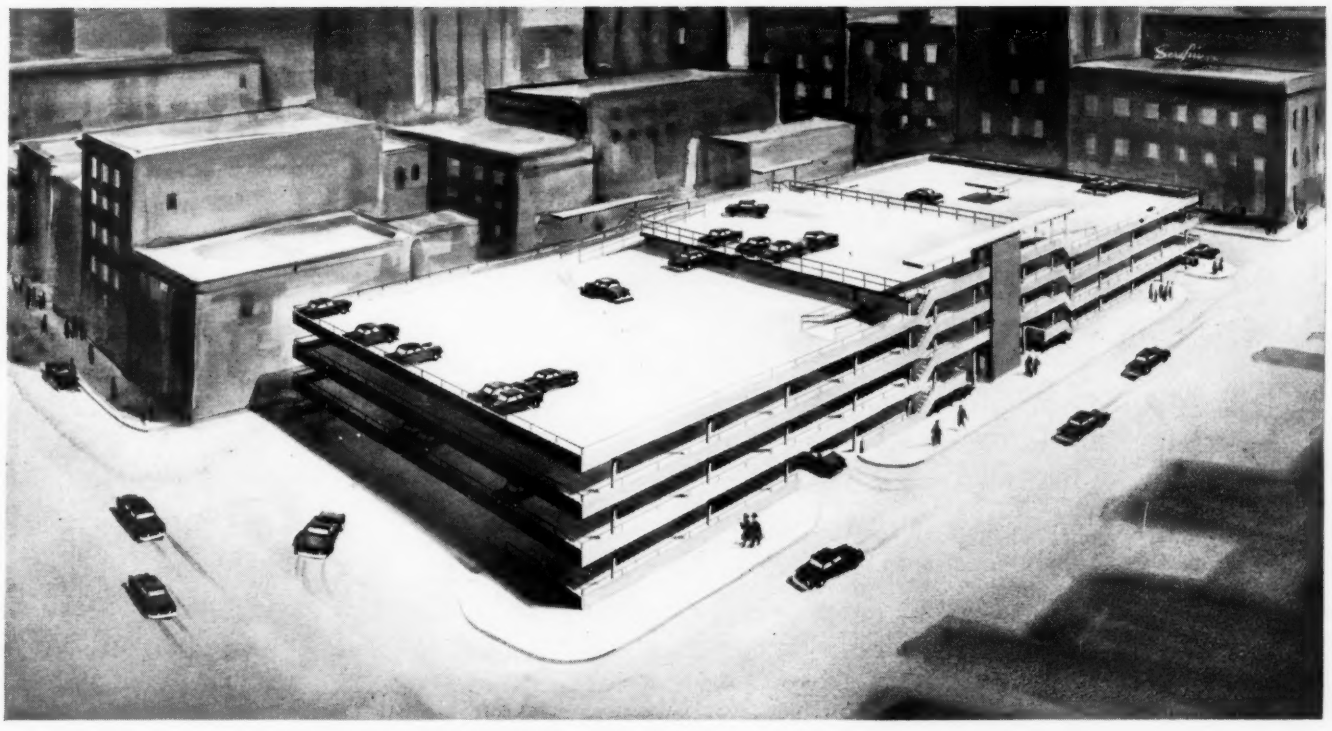
Parking Facility Number 5, planned for southeast corner of Rush and Delaware Place

Chicago's Solution To The Parking Problem

WILLIAM R. McCONOCHIE
Chief, Traffic and Transportation Section
De Leuw, Cather & Company

The City of Chicago has embarked on a $50,000,000 municipally-owned parking facility venture. Bonds in the amount of $22,600,000 were sold in December, 1952 for five garages in the Central Business District, four garages on the Near North Side and eight parking lots in the 63rd and Halsted Area, a principal outlying shopping center. The funds will also be used to make the remaining payments on the City's recent purchase of parking meters which will total 27,000 when the current program is completed.

Additional bonds will be sold to build other facilities until a total of $50,000,000 has been expended or engineering estimates show that net revenues produced by further expanding the system will reduce the coverage of bond service charges below 1.5. "Coverage" is the factor computed by dividing net



Proposed parking deck, southeast corner of Congress and State

WILLIAM R. McCONOCHIE

The author graduated from the University of Michigan in 1928 with a degree of B. S. in C. E. After a short period with the U.S. Army, Corps of Engineers, he joined the Chicago Surface Lines as traffic engineer on special studies in connection with the planning operations and economics of a major transit company. Mr. McConochie lectured at Northwestern University Traffic Institute during 1942-44 on traffic and transit engineering.

In 1944 he joined the firm of De Leuw, Cather & Company as Chief of the Traffic and Transportation Section. His work has covered parking studies, highway planning, public transportation improvements and many other phases of transportation in more than 40 cities in 21 states.

He is a member of the American Society of Civil Engineers, Institute of Traffic Engineers, and Western Society of Engineers. He holds professional engineer licenses in a number of states.

In addition to his connection with De Leuw, Cather & Company, he is an associate member of the New York consulting firm of De Leuw and Brill.

revenues after paying all operating and maintenance expenses by the sum required to meet all interest and amortization charges on the bond issue.

The project was initiated by the City when it asked the Chicago Association of Commerce and Industry and the State Street Council to sponsor a survey of the parking needs of the Central Business District. Results of this survey plus a demonstrated acute shortage of parking space in community business districts and congested residential areas throughout the City led to the employment of a banking group to report on the feasibility of financing a parking program with revenue bonds. The banking group was headed by Blyth & Co. Inc., and included Smith Barney & Co.; Harriman, Ripley & Co. Incorporated; Forgan & Co.; and John W. Clark, Incorporated, all having offices in Chicago.

The banking group entered into a contract with the City of Chicago in January, 1952. This contract provided that the City would incur no financial obligations for the bankers' fiscal services. The bankers employed Chapman and Cutler as bond counsel and De Leuw, Cather & Company as consulting engineers.

The financing is based on 3-¾ per cent, 30-year bonds, the principal and interest being payable solely from the revenues of the parking facilities which include the 27,000 parking meters. The bonds were offered to investors at par through a group of 52 investment dealers.

The City's entrance into the field of off-street parking is authorized by Article 52.1 of Chapter 24, Ill. Revised Statutes, 1951. The Parking Authority

TABLE 1 — ESTIMATES OF COST FOR PARKING FACILITIES

	Capacity in car spaces	Cost of site including land and improvements	Cost of construction including contingencies	Total cost
Project A-1				
Five proposed parking facilities for the central business district	3,879	$3,102,000	$ 6,748,000	$ 9,850,000
Four new lots and four existing lots at the 63rd and Halsted shopping center	1,302	$1,218,000*	$ 225,000	$ 1,443,000
27,000 parking meters	27,000	—	$ 1,200,000**	$ 1,200,000
Total project A-1	32,181	$4,320,000	$ 8,173,000	$12,493,000
Project A-2				
Four proposed parking facilities for the North Michigan Avenue area	2,888	$2,306,000	$ 4,315,000	$ 6,621,000
Grand total	35,069	$6,626,000	$12,488,000	$19,114,000

*It is proposed to lease one parcel, presently used as a parking lot. The cost of leasing is included under Maintenance and Operation.

**Cost of meters includes the remainder to be paid on 22,000 meters in operation and the purchase of 5,000 new meters now authorized.

Act, which was submitted to the Illinois legislature in 1947, has been tested in the State Supreme Court and given clear and complete approval. The Act does not permit any services in the proposed garages other than the parking of cars.

Engineering Services

Engineering services furnished to the bankers included the preparation of parking programs for immediate construction in each of three business areas in Chicago. General plans and specifications were prepared for each of the facilities recommended and estimates were made of the costs of sites and of construction. Estimates were also made of gross income, maintenance and operating expenses, and net revenues available to meet bond service charges or for deposit in various funds as required or authorized by the bond ordinance.

General features of the program as finally developed, including capacity, cost, and estimated operating results, are shown by Tables 1, 2, and 3. It will be noted that the studies contemplated an interest rate of 3½ per cent. Changes in market conditions between the time the Engineer's studies were completed and the time the bonds were offered for sale necessitated the increase to a 3-¾ per cent coupon.

Parking studies in the Central Business District covered the areas tributary to each of five potential sites which had been proposed in earlier studies. These surveys developed the current supply and usage of existing off-street parking space and estimates of total demand from which present deficiency in capacity could be determined. Studies were also made of existing parking rates in each area, average charge per car parked, characteristics of rush hour peaks, and other pertinent factors.

On the basis of these studies, the engineers recommended three ramp garages and two elevator garages with a total capacity of 3,879 cars. These garages will cost approximately $9,850,000.

On the Near North Side, known also as the North Michigan Avenue Area, similar studies of parking needs produced a program for immediate construction including one elevator garage and three ramp garages. Total capacity of these four facilities would be 2,888 cars and the cost about $6,620,000.

The 63rd and Halsted retail section is first in dollar volume of sales among neighborhood shopping centers. The consulting engineers' studies in this area included inventory of curb and off-street parking space and complete studies of the current usage.

Merchants Pay Fees

There are four large lots in this area at the present time operated by individual stores for the free use of their customers. In order to make the provision of additional parking lots financially feasible, it was deemed necessary by the Engineer for the City to acquire all of these existing lots so that parking charges would be uniform throughout the area.

The merchants who had previously furnished free parking requested that they have the option under the new program of paying the parking fees of their customers. This led to the recommendation that the lots be operated with a ticket system and attendants rather than with parking meters or with coin-operated gates.

Merchants who wish to pay for customer parking

TABLE 2 — ESTIMATED GROSS REVENUES, MAINTENANCE AND OPERATING EXPENSES, AND NET REVENUES—1958 LEVEL

	Estimated annual gross revenues	Estimated annual cost of maintenance and operation	Net revenues
Five proposed parking facilities for the central business district	$1,526,000	$ 518,000	$1,008,000
Four proposed parking facilities for the North Michigan Avenue area	953,000	387,000	566,000
Four new lots and four existing lots in the 63rd and Halsted shopping center	177,000	58,000	119,000
Parking meter program (27,000 meters)	1,420,000*	650,000	770,000
Totals	$4,076,000	$1,613,000	$2,463,000

*The total amount available to the parking program from parking meter revenues equals 70 per cent of the gross = 0.70 x $2,025,000.

will be furnished sheets of gummed and perforated Parking Lot Stamps at their face value. One stamp will be attached to a customer's parking ticket at the time of each purchase in the participating merchant's store. This will allow the small stores to offer essentially the same parking privileges to their customers as those now provided only by banks and major department stores.

The fee paid by the parker will be reduced by ten cents for each stamp affixed to his ticket. Those using the lots without acquiring Parking Lot Stamps on their tickets will pay the standard parking fee of ten cents per hour.

The eight lots will hold about 1,300 cars and will cost approximately $1,500,000 including improvements on the four existing parking lots.

Future Plans

It is expected that additions to the program will consist of developments similar to the 63rd and Halsted Street program in a number of the City's outlying shopping centers. There are 65 recognized shopping centers in the City, of which about 20 are classified as major. De Leuw, Cather & Company has been retained for additional work on this program by the bankers, who in turn have signed a new agreement with the City of Chicago similar to the contract under which the first bond issue of $22,600,000 was successfully handled.

Another interesting phase of this entire program is that the City has pledged 70 per cent of the gross revenues from parking meters toward amortization of total bond issues for the parking program. It is estimated that 70 per cent of the income of the approximately 27,000 meters now installed or on order will be about $1,420,000 annually. The cost of maintenance and operation, but not including enforcement, will be paid from the revenues of the parking program. These expenses are estimated at $650,000 per year.

The City has pledged that the remaining 30 per cent of gross revenues from parking meters will be used for enforcement of parking regulations. In addition, the bond ordinance permits the contribution of certain funds of the parking program for enforcement purposes when recommended by the City.

Administration and Operation

The new off-street parking program, once it is in operation, will be administered by the Commissioner of Streets and Sanitation, Mr. Lloyd M. Johnson. The City Council has established a Bureau of Parking for this purpose.

In the meantime, property is being acquired and construction is being planned by Chicago's new Bureau of Engineering under the direction of Public Works Commissioner Virgil E. Gunlock. Actual preparation of contract drawings and specifications will be carried on by nine architectural firms.

Under terms of the Enabling Act, approval of the Chicago Plan Commission must be obtained insofar as establishment and operation of proposed off-street facilities are concerned.

The Mayor has appointed two leading real estate men as his advisers in connection with the acquisition of property. They are to review all offers for real estate made by the City and are to approve all settlements that are negotiated with owners. Where settlements cannot be negotiated, property will be taken by eminent domain proceedings.

The City is empowered to grant leases or management contracts for any or all of the parking facilities, except curb parking meters, to private operators, but the City will retain control over rates and quality of service. If the City fails to receive satisfactory bids for operating leases or management contracts, it can

operate the lots and garages with its own managers.

The parking fees charged initially must be at least as high as those recommended by the engineers in their report. These rates were established at levels comparable to those charged in privately-owned and operated lots or garages in the vicinity of each project.

The City must increase the parking fees if, at any time, the net revenues of the entire program, after operating and maintenance expenses, are less than one and one-half times debt service charges. The City can reduce fees only after a study by the independent engineer, De Leuw, Cather & Company, shows that the anticipated earnings under the revised rates will be sufficient to satisfy all requirements of the bond ordinance.

The bond ordinance requires the independent engineer to inspect the parking facilities, make reports thereon, and advise and make recommendations to the City in connection with the operation thereof.

Attracts Business

A recent occurrence indicates the wisdom of the City in embarking on this publicly-owned parking program to protect established property values and to slow the migration to the suburbs of new commercial and industrial developments.

After announcement of the program, the Continental Assurance Company acquired an entire block of property approximately 218 feet by 600 feet adjacent to the largest garage to be erected in the North Michigan Avenue Area. Officials of the company state that the proposed garage was an important factor in their selection of this building site for investment purposes.

Studies made during the past year indicate that $50,000,000 may not be enough to give Chicago all of the municipally-owned parking facilities it needs. Not only the business districts but many of the residential areas are desperately in need of places to park the growing flood of automobiles.

The bond ordinance provides for this future contingency. Additional parity bonds beyond $50,000,000 may be issued, but only after the parking facilities have been in operation for more than twelve months, and it is estimated by De Leuw, Cather that the net earnings for the twelve months combined with the estimated net earnings of the proposed facilities will cover debt service one and one-half times.

Also, to stretch the bond dollars over more of Chicago's 212 square miles, some of the parking lot sites may be acquired on long-term leases rather than by purchase. This, too, is provided for in existing authorizations.

Chicago, the Giant by the Lake, is taking giant strides toward solving its parking problems.

TABLE 3 — ESTIMATED ANNUAL REVENUES, EXPENSES AND INDICATED COVERAGE

$22,600,000 30-Year 3½ per cent bonds to be amortized over a 27-year period

Year	Gross annual revenues					Total maintenance and operating expenses	Net revenues	Interest and amortization 27-year— 3½%	Indicated coverage**
	CBD* revenue	NMA* revenue	STH* revenue	Meter revenue	Total revenue				
1953	Construction		$ 61,000	$1,420,000	$1,481,000	$ 673,000	$ 808,000	Construction	
1954	Period		159,000	1,420,000	1,579,000	708,000	871,000	Period	
1955	$1,297,000	$810,000	164,000	1,420,000	3,691,000	1,541,000	2,150,000	$1,295,000	1.66
1956	1,373,000	858,000	168,000	1,420,000	3,819,000	1,567,000	2,252,000	1,295,000	1.74
1957	1,450,000	905,000	173,000	1,420,000	3,948,000	1,595,000	2,353,000	1,295,000	1.82
1958	1,526,000	953,000	177,000	1,420,000	4,076,000	1,613,000	2,463,000	1,295,000	1.90
1959	1,526,000	953,000	182,000	1,420,000	4,081,000	1,613,000	2,468,000	1,295,000	1.91
1960	1,526,000	953,000	186,000	1,420,000	4,085,000	1,613,000	2,472,000	1,295,000	1.91

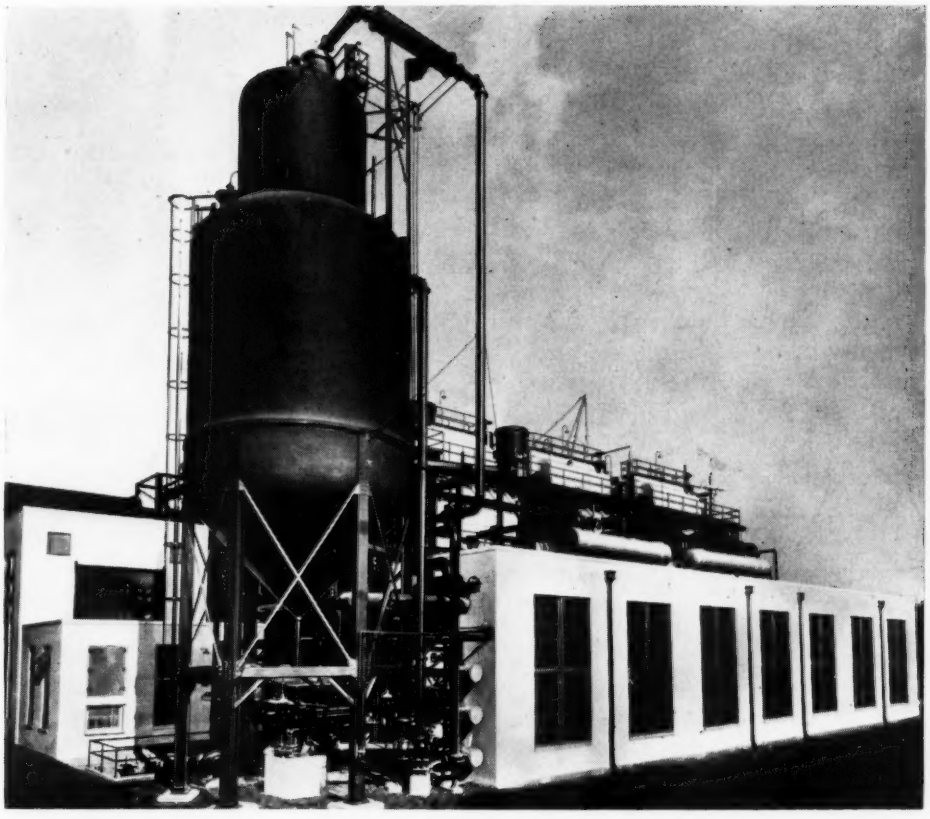
*CBD = central business district

NMA = North Michigan Avenue area

STH = Sixty-third and Halsted shopping center

**The above indicated coverage shown in the last column is based upon the principal amount of bonds sold. Additional parity bonds which may be issued under this authorization may increase or decrease the indicated coverage, but in accordance with the ordinance additional bonds may not be issued if the estimated operating revenues would reduce coverage below 1.50 times.

Photograph of typical outdoor installation illustrates unit that heats and deaerates feedwater by three stage reboiling process



J. D. YODER
Vice President
The Permutit Company

Reboiling Spray Deaerators for Public Utility Power Plants

J. D. Yoder, Vice President and Manager of the Boiler Feedwater Division of The Permutit Company, has had over 40 years of experience in boiler feedwater treatment. Graduating from the Chemical Engineering Department of the University of Michigan in 1912 with degrees of BS and MS, he was attracted to boiler feedwater treatment by some research work he had performed on the effect of temperature on the precipitation of calcium carbonate. Mr. Yoder's interest in this field has continued without interruption. He is well known for his successful inventions and his technical papers on water conditioning.

Reboiling spray deaerators were developed primarily for application to hot process softeners where their chief advantage lay in the fact that they were less troubled by scale than tray type deaerators. Subsequently, they were offered for deaeration of highly corrosive waters such as the blended effluents from sodium and hydrogen zeolite softeners which were saturated with oxygen, low in alkalinity, and high in free CO_2.

Utilization of reboiling spray deaerators was extended to all types of industrial power plants that frequently have 100 per cent makeup, saturated with oxygen. Such waters often have 200 times as much oxygen as is normally found in feedwater from surface condensers. Many reboiling spray deaerators, ranging from 10,000 to 3,000,000 lb per hr in capacity, have been supplied for industrial plants. All of these have been guaranteed to reduce the oxygen to less than 0.005 ml per liter, which is commonly known as zero oxygen. However, this type of deaerator has not been used extensively in public utility power plants although it has many advantages for this service.

These units heat and deaerate water in three stages, as shown in Fig. 1. The first stage is primarily a vent condenser, or compartment for concentrating noncondensable gases. The second stage, called spray compartment, heats the water nearly to the boiling temperature and removes most of the noncondens-

able gases. Then hot and partially deaerated water passes to the third, or reboiling stage, for final and complete deaeration. Vigorous boiling in the scrubber with a large excess of oxygen-free steam is largely responsible for the high quality performance.

There is a small pressure loss as the steam passes through the distributing perforations and the scrubber. Sometimes, this loss is exaggerated by engineers who are not well acquainted with this type of deaerator. They overlook the fact that the steam passing upward through the scrubber at high velocity gives a lift to the water so the actual pressure loss is very small. This pressure loss is illustrated by Fig. 2, and includes the loss through the steam perforations as well as through the scrubber.

It is approximately 1/3 lb at atmospheric pressure and gradually increases with higher steam pressure to 0.7 lb at 125 psia. When compared with the acceptable pressure loss between the extraction turbine stage and heater, this loss is negligible and does not affect the normal heat balance.

An evaluation of the effect of this pressure in terms of kilowatts per 100,000 lb per hr deaerator capacity is presented in Fig. 3. In comparing this information with Fig. 2, it is noticeable that while pressure loss through the scrubber increases slightly at higher steam pressures because of the greater steam density, the energy loss becomes less as the pressure increases because equal pressure increments have less heat value at the higher pressures.

TABLE 1—OXYGEN IN DEAERATOR EFFLUENT

Turbine load megawatts	Evaporator off ml per liter	Evaporator on ml per liter	Steam from evaporator per cent
15	0.0005	——	——
20	0.0000	0.0064	20.2
40	0.0009	0.0027	56.0
60	0.0010	0.0012	46.4
80	0.0027	0.0039	34.5

At a pressure of 50 psia, the energy loss is only 0.9 kw per 100,000 lb per hr deaerator capacity. If the deaerator operated with a 50 per cent load factor throughout a 24 hr period, and if all the heating steam came from the normal extraction stage, this would be equivalent to a daily energy loss of 11 kwh. This value is dependent upon plant heat rate and fuel cost and is normally less than ½¢ per kwh, or 5½¢ per day. For a 1,000,000 lb per hr deaerating heater the energy loss would be equivalent to 55¢ per day. If the pressure in the deaerating heater were to be pegged by supplementing steam from a higher pressure stage, the loss would be even smaller. Thus, it is found that the value of the energy loss becomes negligible, or in any event is easily justified by the better deaerating performance it produces.

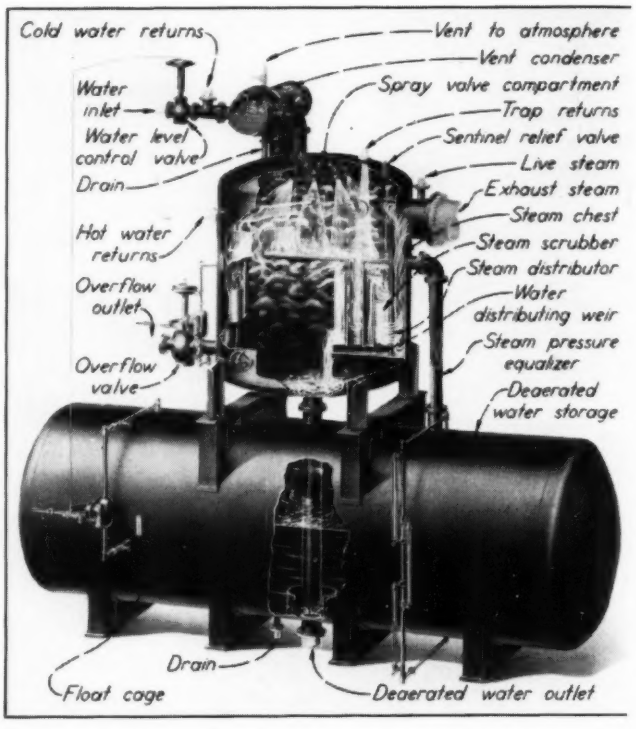


Fig. 1—Cutaway view reveals internal construction of a reboiling spray deaerator with horizontal storage tank

The measure of efficiency of a deaerating heater is the completeness with which it removes oxygen and carbon dioxide from the feedwater. Careful tests have been made to determine heater effectiveness in accomplishing this function, and several of these studies are cited to illustrate typical results.

Case 1—Removing Oxygen

This test was conducted on a deaerator serving a 900,000 lb per hr boiler operating at 1400 psig in a public utility power plant. The heater was operated on the third extraction point of the turbine, and normally received steam from an evaporator whose coils were supplied with steam from the fourth extraction point. The evaporator was fed with undeaerated water saturated with oxygen. All the oxygen in the evaporator feed was expelled with the steam which entered the scrubber of the main deaerator.

The primary purposes of the deaerator test were to determine: (a) the effectiveness of the deaerator at various operating loads, and (b) the effect of using oxygen-contaminated vapor in the steam scrubber. Two series of tests were made, one with all deaerating steam taken from the extraction stage of the turbine, the other while using all available vapor from the evaporator, plus additional steam as required from the extraction stage of the turbine. These tests were performed in accordance with the method and procedure for oxygen determination recom-

mended by the Heat Exchange Institute. The results recorded in Table 1 are averages of three or four tests for each rate of operating the turbine.

These tests clearly demonstrate the high efficiency of the deaerator for removing oxygen from the water, particularly when steam delivered to the scrubber is not contaminated with oxygen, as shown by column headed "Evaporator off". The tests also show that when the steam is contaminated with oxygen deaeration is less effective.

Case 2— Removing Total CO_2

These studies were made on an evaporator deaerator at a public utility plant (1) with boilers operating at 1600 psig. Water fed to the deaerator came from a hydrogen zeolite softener and had approximately 30 ppm of free mineral acidity. This water was deaerated while still acid for the purpose of complete removal of free CO_2. If the water contains even a small amount of bicarbonate alkalinity, some free CO_2 will be expelled with the vapor. To avoid this, the evaporator feedwater was deaerated while acid in a stainless steel deaerating heater.

Carbon dioxide is more difficult to remove from water than oxygen because of its higher solubility and the fact that it combines with water to form H_2CO_3. Also, it is more difficult to measure small quantities of carbon dioxide than small amounts of oxygen, but after making careful tests it was found that free CO_2 was reduced to approximately 0.04 ppm, which was the limit of accuracy for making the test. This test again demonstrated a high degree of deaerator performance.

Case 3—Removing CO_2 of Bicarbonate Alkalinity

Further tests have been conducted to determine the effectiveness of the deaerator for removing not only free CO_2 but also the CO_2 of bicarbonate alkalinity under high steam pressure. These tests were made at five different plants, all of which had low bicarbonate alkalinities varying from 10 to 18 ppm. The deaerators were operated at different steam pressures and the results are given in Table 2.

Removal of CO_2 by deaeration beyond that originally present as free CO_2 is accomplished only because of dissociation of the bicarbonate radical. This dissociation is an equilibrium reaction and continues only as long as the dissociated free CO_2 is removed from the water. A pH of 8.3 indicates that all free CO_2, as determined by the titration method of APHA, is removed. Higher pH values indicate a greater extent of dissociation and CO_2 removal. Table 2 clearly shows higher pH values of deaerator effluent with increasing steam pressures, and therefore greater dissociation and CO_2 removal.

Since dissociation is a function of temperature rather than steam pressure, a curve was plotted, Fig. 4, to show the relation of temperature and deaeration to pH of the effluent. This curve is not intended to show the theoretical results obtainable, but reveals actual results obtained in field tests. Various methods of determining pH value were used and they were not intended to give ultimate accuracy. However, it is interesting to note how nearly the determined points approached the straight line curve of relationship between temperature and pH.

Fig. 4 proves that with efficient deaeration, the pH value is increased substantially with increasing steam temperature. The most remarkable results of this series of tests are those obtained at Plant 5 which operated at a temperature of 350 F corresponding to a steam pressure of 120 psig. Detailed results of that particular test are given in Table 3.

In removing CO_2 from an alkaline water by deaeration, the free CO_2 is first removed. Next, half the CO_2 of the bicarbonate alkalinity is removed which changes the bicarbonate to normal carbonate alkalinity (CO_3). Finally, the CO_2 of the normal CO_3 is removed to produce sodium hydroxide (NaOH).

As shown by Table 3, the deaerator has removed all free CO_2, all bicarbonate (HCO_3), and more than half of the normal carbonate (CO_3) alkalinity. In other words, a chemical titration test showed the absence of free CO_2 and HCO_3, while the reduction to approximately 50 per cent sodium carbonate, and 50 per cent sodium hydroxide gives a pH of 10.1.

TABLE 2—EFFECT ON pH OF DEAERATION AT DIFFERENT STEAM PRESSURES

Plant	Deaerator capacity lb per hr	Steam pressure for deaeration psig	Methyl orange alkalinity of effluent ppm as $CaCO_3$	Influent pH	Effluent pH
1	60,000	1	10	5.6-6.0	8.4
2	200,000	5	18	6.6-7.4	8.7
3	1,400,000	14	16	6.8	8.9
4	200,000	28	18	7.4-7.8	9.4
5	750,000	120	11	6.4	10.1

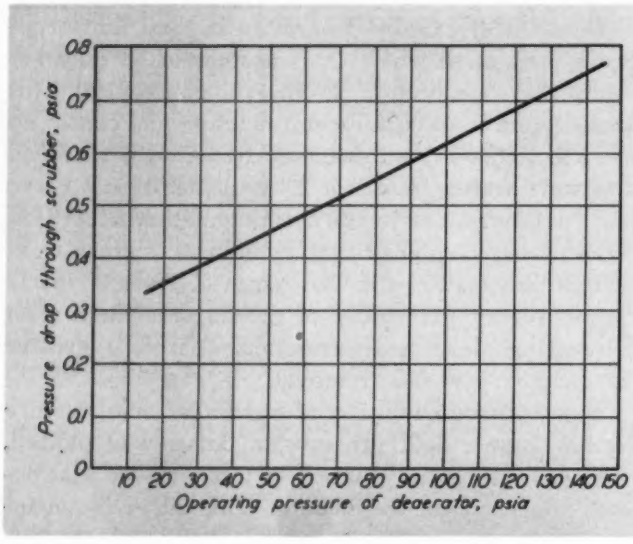


Fig. 2—Pressure drop in distributor and scrubber

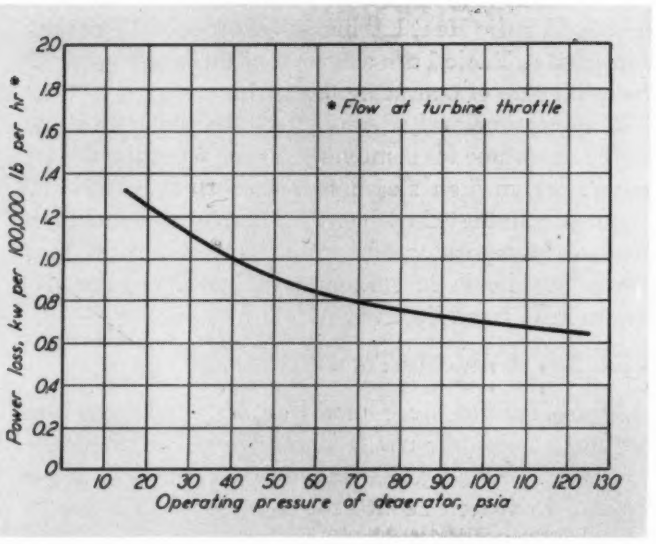


Fig. 3—Power loss due to pressure drop in deaerator

Curves, Fig. 5, plotted by T. R. Camp, Massachusetts Institute of Technology (2), show the ratios of free CO_2, HCO_3, and CO_3, at a temperature of 18 C (64 F) for various pH values. At this temperature, 11 ppm sodium bicarbonate has a pH of 8.4, and these curves indicate that when this is dissolved in water, it dissociates to give 1.15 per cent H_2CO_3, 97.38 per cent HCO_3, and 1.47 per cent CO_3 in molar concentration. The dissociated hydroxyl ions in the presence of this alkalinity are insignificant and are not shown on the ratio chart, Fig. 5.

At a temperature of 350 F (178 C) the extent of dissociation is somewhat greater, and possibly enough to give 2.0 per cent H_2CO_3, or a total of 0.2 ppm free CO_2 by dissociation of 11 ppm sodium bicarbonate ($NaHCO_3$) in terms of $CaCO_3$. Since deaeration can only remove CO_2 when present as a gas (H_2CO_3) the question is, how is it possible to remove so much CO_2 as indicated for Plant 5? The answer is that when free CO_2 is removed, the equilibrium is upset and more free CO_2 is dissociated. That CO_2 can be removed and that dissociation can proceed at this rate is remarkable. It demonstrates the high degree of turbulence in the scrubber and efficiency of gas removal by the reboiling deaerator. The steam was in the scrubber only ¼ second. The time that water was in the scrubber cannot be determined accurately, but it was probably less than five seconds.

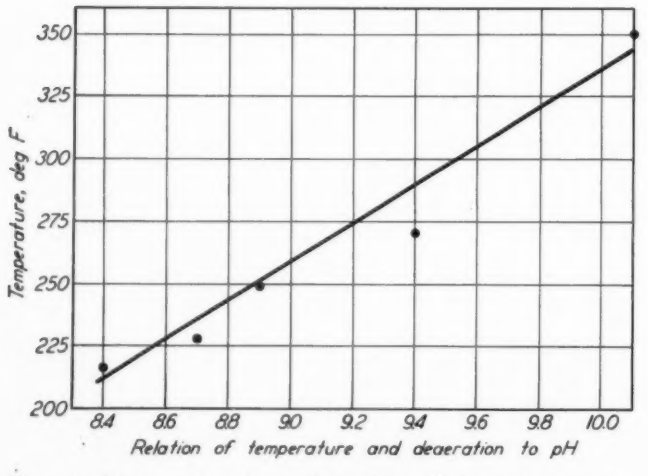


Fig. 4—Test results show that with efficient deaeration, effluent pH value increases with increasing temperature

All these tests (3) demonstrate a high degree of deaeration. The question now arises, how is it possible to obtain such a high degree of deaeration with a reboiling spray deaerator? The answer is chiefly: (a) the actual boiling of the water, and (b) the high steam velocity, vigorous agitation, and rapid turbulence of the water in the scrubber. It is impossible to obtain these conditions in a deaerating heater where the steam merely surrounds and heats water as it falls over trays. From a theoretical standpoint, the most that can be accomplished with tray type designs is to heat the water to the boiling temperature.

With a pressure drop of 1/3 psia in the scrubber at atmospheric pressure, the incoming steam temperature is approximately one degree higher than the temperature of steam at the water surface of the deaerator. The large excess of steam and rapid turbulence heats the water in the scrubber to a higher temperature than steam within the deaerator. This causes a small amount of flashing as the water leaves the scrubber which insures boiling. Furthermore, the high turbulence of steam and water in the scrubber gives the additional effect of vigorous boiling.

Since oxygen and CO_2 in the feedwater of a public utility power plant is less than one per cent of what may be present in feedwater for industrial plants employing 100 per cent makeup, deaeration for these plants may be regarded less important than for industrial plants. However, in some respects it is more important because public utilities normally operate at higher pressures, and use high stage feedwater

heaters that heat the water to a much higher temperature before entering the boilers than is normally done in industrial power plants.

Most of the iron pickup of the water takes place in the feed cycle and then is deposited in the boiler. The best way to avoid iron pickup is to remove all oxygen and CO_2, and to control the pH of the boiler feedwater. Simply removing CO_2 will not raise the pH value sufficiently to prevent iron pickup so that further chemical treatment, as with ammonia or amines, may be required. Complete removal of oxygen and CO_2 substantially reduces the chemical treatment required and improves performance. Good deaeration of feedwater for high pressure boilers of public utilities is therefore of great importance.

There is another reason why public utilities should provide the best possible deaeration of boiler feed. Sodium sulfite, frequently utilized in low pressure boilers, dissociates at pressures above 1200 psig and gives off sulfur dioxide with the steam. This reduces the pH and causes corrosion and iron pickup in the wet stages of the turbine and feed lines. By removing all the oxygen from the feedwater, as may be done by reboiling it with oxygen-free steam, the feeding of sodium sulfite can be omitted.

From an operating standpoint, reboiling spray deaerators are well suited for floating on an extraction turbine pressure stage. If the load on the turbine drops causing the pressure at the turbine stage to fall below the pressure corresponding to the temperature of the deaerated water storage, some steam will flash from storage to heat the incoming feedwater. This flashed steam passes through the scrubber and insures continuous deaeration even though the pressure at the turbine stage has dropped sufficiently to close the nonreturn check valve in the steam line connecting the turbine stage with the deaerator. In this event, all of the heating steam flashes from storage and passes through the scrubber for deaeration.

Furthermore, the slightly higher steam pressure in the storage tank than in the deaerator during a falling turbine load tends to reduce any flashing that might otherwise occur in the boiler feed suction piping. As a further aid to avoid flashing in the pump suction, the incoming deaerated water, which is slightly lower in temperature than the water in storage, is directed to the pump supply outlet within the surrounding baffle. Both of these factors tend to reduce possibilities of flashing in the suction piping.

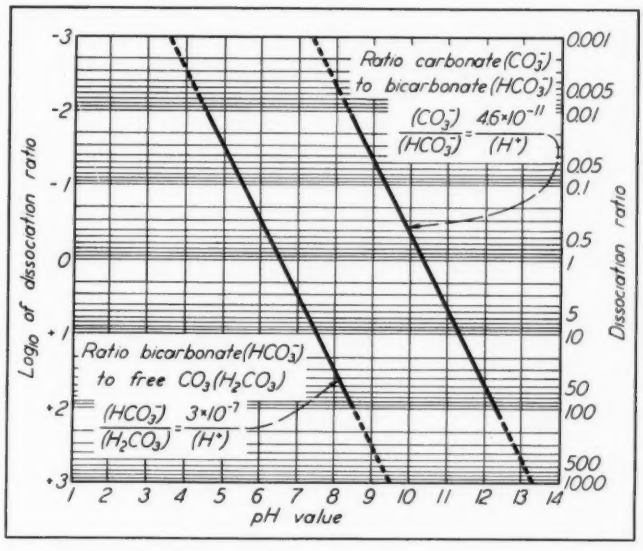


Fig. 5—Bicarbonate dissociation ratios at 18 C (64 F)

Conclusion

Reboiling spray deaerators were developed originally for use with the hot lime soda water softener in industrial plants to overcome the scaling tendencies of the tray type deaerator. Later, its use was extended to deaerating completely softened water in industrial power plants and evaporated water in public utility plants. Results of tests made on the removal of dissolved oxygen and carbon dioxide from various feedwaters indicate public utility plants can obtain many benefits by using this type deaerator.

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(1) "Progress in Iron Pickup Control in the Generating Station Water-Steam Cycle"
E. L. Archibald, Supervising Engineer and J. W. Purssell, Mechanical Production Engineer, Boston Edison Company
American Power Conference, Vol 14, pages 443-452, 1952

(2) "Deaeration Increases pH"
J. D. Yoder, Vice President, The Permutit Company
1941 Water Conference
Engineering Society of Western Pennsylvania

(3) The author acknowledges, with thanks, the assistance of R. H. Marks, Engineering Division, in the evaluation of energy loss of the deaerator at various operating pressures, and C. F. Paulson, Research Division, and M. P. Howie, Service Division, for the field analytical work on carbon dioxide and dissolved oxygen removal.

TABLE 3—CO_2 REMOVAL BY DEAERATION AT 120 PSIG

← Deaerator influent →				← Deaerator effluent →				
ppm as CO_2	ppm as $CaCO_3$	ppm as $CaCO_3$	ppm as CO_2	ppm as CO_2	ppm as $CaCO_3$	ppm as $CaCO_3$	ppm as $CaCO_3$	ppm as CO_2
Free CO_2	HCO_3	CO_3	Total CO_2	Free CO_2	HCO_3	CO_3	OH	Total CO_2
1.0	11	0.0	10.7	0.0	0.0	5.0	6.0	2.2

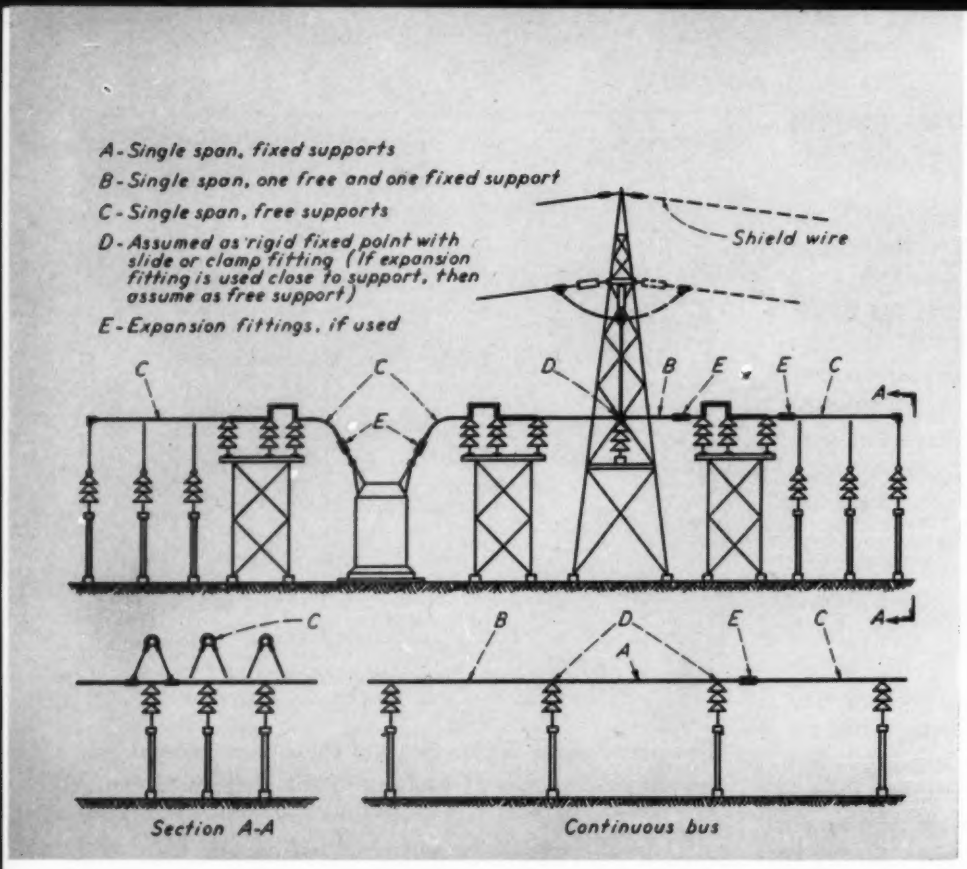
A - Single span, fixed supports
B - Single span, one free and one fixed support
C - Single span, free supports
D - Assumed as rigid fixed point with slide or clamp fitting (If expansion fitting is used close to support, then assume as free support)
E - Expansion fittings, if used
Shield wire
Section A-A
Continuous bus

Fig. 1—The diagram suggests typical applications for the limiting spans tables in designing bus structures, subject to notes in the table below. Design information and recommendations are in greater detail in Fig. 5

Frank E. Reeves is now coordinator on design of several large power plants and substations and is consultant on operating problems of utilities in ten foreign countries with Ebasco International Corp. With degrees of SB and SM in EE, MIT, 1925, he spent 18 yr with Boston Edison Co. field testing utility equipment. Afterwards, he designed several hundred control circuits for machine tool and other manufacturers, and wrote and published *"Manual of Electrical Control"*. For Fay, Spofford and Thorndike, he supervised electrical design for a steam-electric plant at Ladd Field, Alaska, and for Barnard and Burke, a municipal steam-electric plant at Lafayette, La., also coordinating construction of the latter. Assigned to Ethyl Corp. in Baton Rouge, he studied short-circuit conditions, relay protection, and technical and economic conditions in the power systems.

Designing Tubular Bus Structures

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Consulting Electrical Engineer

Since many factors in bus design are dependent upon one or more of the others, procedure is not straightforward, involving as it does, some cut and try steps. For a particular installation, innumerable designs will provide essentially satisfactory electrical and mechanical results. Cost and availability of components usually determine the final choice.

The most important factors involved in the design of bus structures are:

1. Shape, arrangement and dimensions of conductors.
2. Spacing between phases.
3. Nature of supports (fixed or free), and span.
4. Deflection due to weight of bus, wind, ice.
5. Temperature rise due to normal current.
6. Deflection due to short-circuit current.
7. Short-circuit stresses on bus supports.
8. Thermal expansion of conductors.
9. Cost and availability of materials.

Of somewhat less importance are:

10. Reactance drop.
11. Skin effect.
12. Corona losses.
13. Proximity effect.

To facilitate design of standard types of bus structures, a step-by-step procedure has been developed and is given here. It may be followed in a majority of cases, but special conditions may require deviation or elaboration.

A brief outline of the recommended procedure is:

1. Select shape and arrangement of bus conductors and spacing for voltage.
2. Find mechanical loading from wind, ice load and weight of buses.
3. Determine short-circuit stresses in buses.
4. Find maximum permissible span for a deflection of 1/150 th of span due to resultant of mechanical loading and short-circuit stresses.
5. Determine if fiber stresses, Step 4, are allowable for the material used.
6. Determine cantilever stresses at supports.

NOTES FOR FIG. 1 AND TABLES 1, 2 AND 3

1. Limiting spans shown in Tables 1, 2 and 3 are for a normal maximum deflection limit of 1/150 th of span. While this is considered good design practice, it is subject to reasonable variations provided maximum fiber stress is not exceeded.
2. The tables are based on uniformly distributed load. Deflection may be calculated for any concentrated load.
3. Allowable spans may be shorter than shown in tables due to short-circuit stress requirements.

7. Repeat procedure with various sizes and materials for conductors to find most economical design.

Step 1 — Shape, Arrangement and Spacing

Carrying capacity usually does not determine size of tubular bus conductors except where very heavy load currents are involved. However, the chart in Fig. 2 will show the relative merits of various shapes of conductors from the standpoint of carrying a-c currents, and may be useful when capacity for the size selected in Step 2 is exceeded.

Ordinarily, standard weight tubing having a diameter larger than necessary for normal load current will prove more economical than extra heavy or double extra heavy tubing. Fewer supports will be required for the larger tubing and corona power losses will be reduced. However, initial determination of size and weight of tubing should usually be made on the basis of deflection (see Step 4).

Copper is most commonly used for electrical bus conductors, but consideration should be given to aluminum from the standpoint of relative availability, cost and weight. The necessarily larger diameters of aluminum conductors will have the tendency to reduce corona and skin effect. However, due to light weight, aluminum conductors are more subject to vibration. Other problems associated with the use of aluminum are:

1. The high resistance oxide which forms quickly on aluminum surfaces must be given special treatment at points of electrical contact.
2. Special techniques are needed for soldering.
3. Serious corrosion of aluminum may occur especially in saline or otherwise contaminated atmospheres, at points of contact with copper and other metals. At these points, copper should be plated with cadmium to prevent electrolytic action.

Steel is occasionally used for bus conductors, but will not be treated in detail here.

Spacing between phases of buses may be determined from NEMA standards for spacings between poles of air-break switches or from Fig. 5.

Step 2 — Mechanical Loading of Bus Conductor

Wind and ice loading will be determined by local conditions and by diameter. Obviously, a particular size of bus must be assumed to find these factors as well as the weight. And since the span may often be determined by dimensions of equipment, it is suggested that size first be determined by assuming

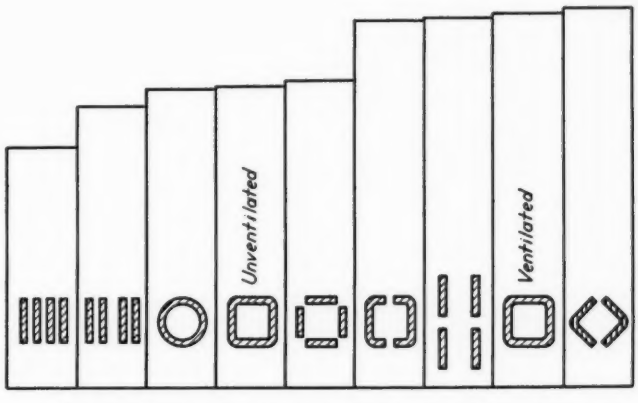


Fig. 2—The a-c ratings of conductors depend on shape and arrangement. The chart shows comparative values based on a cross section of 4 sq in. each. By courtesy of Burndy Engineering Co.

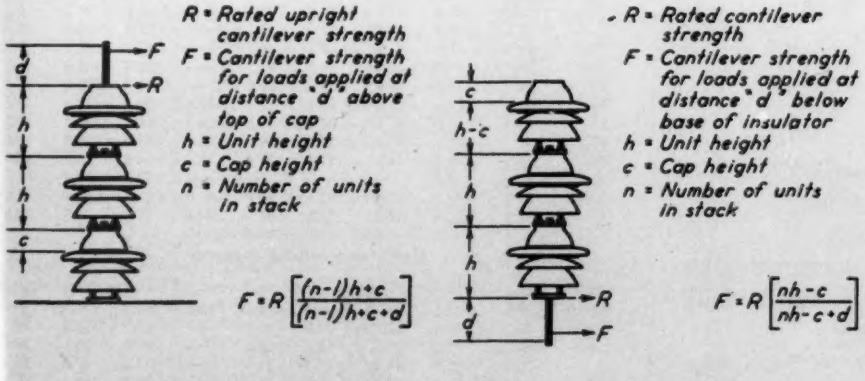

R = Rated upright cantilever strength
F = Cantilever strength for loads applied at distance "d" above top of cap
h = Unit height
c = Cap height
n = Number of units in stack
$F = R\left[\frac{(n-1)h+c}{(n-1)h+c+d}\right]$
R = Rated cantilever strength
F = Cantilever strength for loads applied at distance "d" below base of insulator
h = Unit height
c = Cap height
n = Number of units in stack
$F = R\left[\frac{nh-c}{nh-c+d}\right]$
Upright mounting
Underhung mounting

Fig. 3—Manufacturers supply strength values for insulators, but if loads are not at standard locations, cantilever strengths must be found as above or by similar calculations. By courtesy of Locke Insulator Corporation

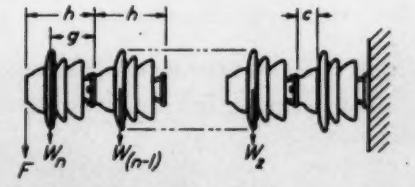

R = Rated cantilever strength
F = Residual cantilever strength available for support of external load
n = Number of units in stack
h = Height of unit
c = Height of cap
g = Distance of center of gravity of each unit above its base
$W_1, W_2, W_3 \cdots W_n$ = Weights of individual units counting from ground end
$F = \frac{R[(n-1)h+c] - W_2(g+c) - W_3(g+c+h) \cdots W_n[g+c+(n-2)h]}{(n-1)h+c}$
If all units have the same weight then
$W_2 = W_3 = \cdots W_n = W$
and $F = \frac{R[(n-1)h+c] - W(n-1)\left[\frac{(n-2)h}{2}+g+c\right]}{(n-1)h+c}$

Fig. 4—This is the formula for load limit for horizontal stacks

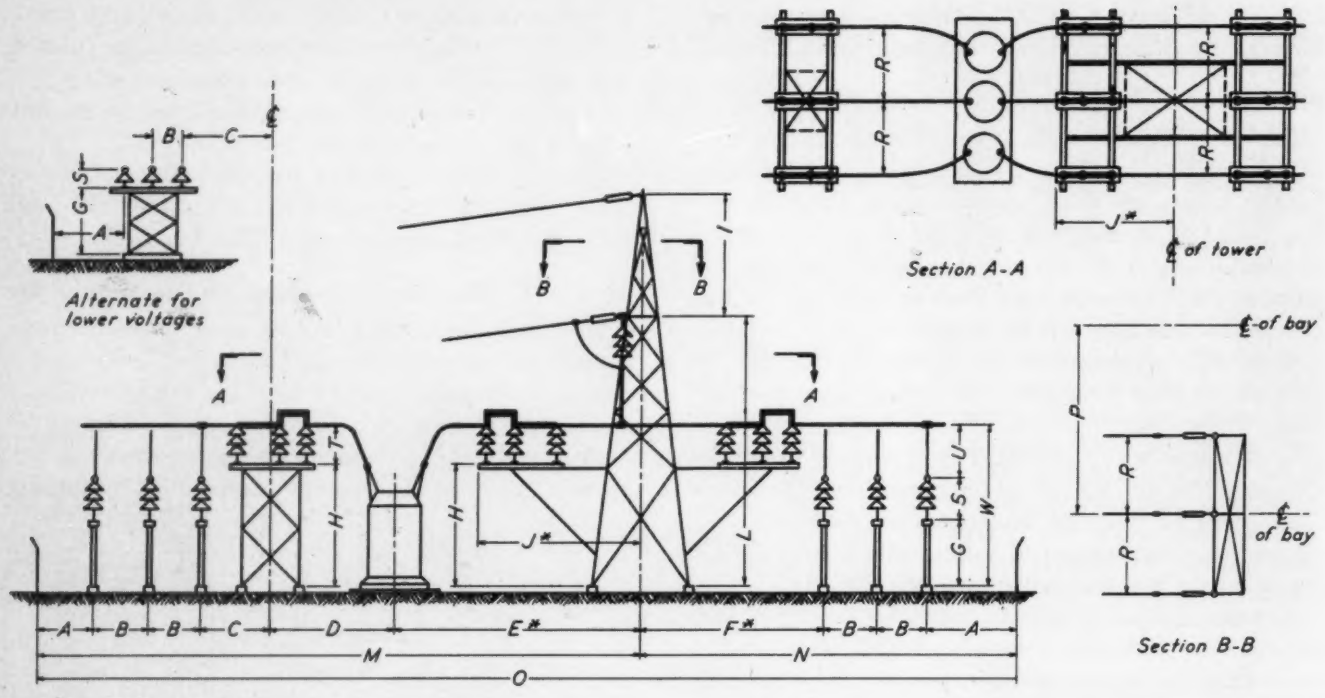


Fig. 5—Typical bus structures are illustrated above, and recommended or NEMA standard dimensions are listed in the chart opposite. These values, with limiting spans from the tables or from graphs, Figs. 6 and 7, facilitate design

span equal to length of one bay and referring to Tables 1, 2 or 3. The span must be classified as to type from Fig. 1.

Knowing bus size and material, weight, wind and ice load (taken in lb per ft) may be determined as first approximations for subsequent steps. Wind pressure (if lb per sq ft) is divided by bus diameter for loading (in lb per ft).

Step 3 — Short-Circuit Stresses In Buses

The formula for determining short-circuit stress in buses is:

$$F^1 = 3.75\ I^2/d$$

for three phase short circuits, where

F^1=peak force on conductor (lb per ft)

I=symmetrical rms current (amp/1000)

d=distance between conductors (in.)

Near generating stations, multiply current by 1.6 if short-circuit current has been calculated using subtransient reactances of generators.

Contributions from induction motors and synchronous motors and condensers must be included if bus voltage is less than 2300 v. Contributions from synchronous motors and condensers must be included.

Step 4—Span Limit for Permissible Deflection

The loads (in lb per ft) due to weight of bus and ice will act vertically downward and may be added arithmetically. Similarly, loadings by wind and short

TABLE 1 — LIMITING SPANS IN FEET AT NO LOAD

Single span—free supports

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	10.0	9.7	10.35	8.5	8.6	—	12.7	12.4	12.7
¾	11.75	11.4	12.1	10.6	10.8	—	14.9	14.6	15.0
1	13.8	13.4	14.2	12.7	12.8	—	17.5	17.1	17.5
1¼	16.1	15.9	16.7	14.6	14.7	—	20.6	20.2	20.6
1½	17.9	17.5	18.3	16.1	16.5	—	22.6	22.3	22.6
2	20.8	20.4	21.3	19.7	19.8	—	26.4	26.1	26.4
2½	23.6	23.2	24.3	22.6	22.8	22.8	30.1	29.5	30.1
3	27.0	26.6	27.7	25.5	25.6	25.7	34.4	33.8	34.4
3½	29.6	29.2	30.3	28.2	28.3	28.4	37.8	37.2	37.7
4	32.0	31.6	32.8	30.7	30.8	31.0	40.8	40.4	41.0
4½	34.6	34.0	—	—	—	—	44.0	43.5	44.1
5	37.2	36.8	37.8	35.6	35.7	36.1	47.4	46.7	47.3
6	42.1	41.3	42.5	40.1	40.3	40.5	53.4	52.6	53.3

Single span—one fixed and one free support

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	13.4	12.85	13.85	11.4	11.5	—	17.0	16.6	17.0
¾	15.75	15.3	16.2	14.2	14.5	—	20.0	19.6	20.1
1	18.5	18.0	19.0	17.0	17.2	—	23.4	22.9	23.4
1¼	21.6	21.3	22.4	19.6	19.7	—	27.6	27.2	27.6
1½	24.0	23.4	24.5	21.6	22.1	—	30.3	29.9	30.3
2	27.9	27.4	28.6	26.4	26.6	—	35.4	35.0	35.4
2½	31.6	31.1	32.6	30.3	30.6	30.6	40.3	39.6	40.3
3	36.2	35.7	37.2	34.2	34.3	34.5	46.2	45.3	46.2
3½	39.7	39.2	40.6	37.8	38.0	38.1	50.7	49.9	50.5
4	42.9	42.4	44.0	41.2	41.3	41.6	54.8	54.2	55.0
4½	46.4	45.6	—	—	—	—	59.0	58.4	59.1
5	49.8	49.4	50.7	47.7	47.8	48.5	63.5	62.6	63.4
6	56.5	55.4	57.0	53.8	54.1	54.4	71.4	70.5	71.5

Single span—fixed supports

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	17.1	16.4	17.7	14.5	14.7	—	21.7	21.2	21.7
¾	20.1	19.5	20.7	18.1	18.5	—	25.5	25.0	25.7
1	23.6	22.9	24.3	21.7	21.9	—	30.0	29.3	30.0
1¼	27.6	27.2	28.6	25.0	25.2	—	35.3	34.6	35.3
1½	30.6	30.0	31.3	27.5	28.2	—	38.7	38.2	38.7
2	35.6	34.9	36.4	33.7	33.8	—	45.2	44.7	45.2
2½	40.4	39.7	41.5	38.6	39.0	39.0	51.5	50.5	51.5
3	46.2	45.5	47.4	43.6	43.8	44.0	58.9	57.9	58.9
3½	50.7	50.0	51.8	48.2	48.4	48.6	64.7	63.7	64.5
4	54.8	54.1	56.0	52.5	52.7	53.0	69.9	69.2	70.2
4½	59.2	58.2	—	—	—	—	75.4	74.5	75.5
5	63.6	63.0	64.6	60.8	61.0	61.7	81.0	79.8	80.9
6	72.0	70.6	72.7	68.6	69.0	69.2	91.4	90.0	91.2

Spans are given in feet for a maximum dead weight deflection of 1/150 th of span.

*Alloy 2S-H18 or 61S-T6.

CHART OF DIMENSIONS FOR FIG. 5 FOR VARIOUS VOLTAGE RATINGS

Rating, kv	A ft, min	B ft	C ft	D ft	E*** ft	F*** ft	G ft-in.	H ft	I ft	J*** ft	L ft	M ft	N ft	O ft	P ft	R** ft	S* in.	T* in.	U* ft	W* ft-in.	Units per Stock	Withstand kv Dry, 1 min	Withstand kv Wet, 10 sec	Impulse	Ground clearance in., min
15	8	2	5	12	16	14	10-6	12	6	—	24	47	28	75	9	3	10	16	2	13-4	1	50	45	110	7
23	9	2.5	5	12	16	14	10-0	12	6	—	24	47	28	75	12	4	12	18	2.5	13-6	1	70	60	150	9
34.5	9	3	6	12	16	14	9-6	12	10	10	24	49	29	78	15	5	15	21	3	13-9	1	95	80	200	11
46	10	3.5	6	12	16	14	9-0	12	10	12	24	51	31	82	18	6	20	25	3.5	14-1	1	120	100	250	15
69	10	4.5	8	14	18	16	12-0	16	12	13	38	59	34	93	21	7	29	36	4.5	19-0	2	175	145	350	22
92	12	5	8	20	24	20	12-3	16	12	16	38	74	42	116	30	10	43.5	59	5	20-10	3	225	190	450	29
115	12	6	10	20	24	20	11-3	16	15	16	42	78	44	122	30	10	43.5	59	6	20-11	3	280	230	550	36
138	12	7	11	22	26	23	10-3	16	15	18	42	83	46	129	36	12	58	73	7	22-1	4	335	275	650	44
161	12	8	12	22	30	25	13-3	20	15	20	45	92	53	145	42	14	58	73	8	26-1	4	385	315	750	52
196	14	10	13	24	—	—	11-3	20	18	—	50	—	—	—	48	16	72.5	88	10	27-4	5	465	385	900	63
230	14	11	14	26	—	—	15-7	25	18	—	50	—	—	—	54	18	87	106	11	33-10	6	545	445	1050	74
287	16	14	—	—	—	—	—	—	—	—	—	—	—	—	66	22	117	140	14	—	8	680	555	1300	90
345	18	16	—	—	—	—	—	—	—	—	—	—	—	—	72	24	117	140	16	—	8	810	665	1550	106

*Dimensions S, T, U and W approximate dependent on manufacturer's equipment mounted on cap and pin type insulators.

**Air break switch spacing—NEMA standard.

***These are dependent on spread of tower legs.

TABLE 2 — LIMITING SPANS IN FEET WITH LIGHT LOADING

Single span—free supports

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	9.1	9.1	8.7	6.65	6.42	—	8.9	9.15	11.4
¾	10.8	10.85	10.2	8.95	8.35	—	10.5	11.1	13.5
1	12.8	12.85	11.9	10.7	10.2	—	12.9	13.5	15.9
1¼	15.35	15.35	14.1	12.3	12.0	—	15.6	16.4	19.2
1½	16.9	16.9	15.7	14.1	13.7	—	17.3	18.3	21.2
2	19.9	19.9	18.1	17.5	17.0	—	20.6	21.9	25.0
2½	22.8	22.8	20.8	20.6	20.5	19.4	25.0	26.0	28.9
3	26.4	26.2	24.6	23.6	23.0	22.3	29.3	30.0	33.4
3½	29.0	28.95	27.5	26.3	25.8	25.2	32.2	33.6	36.6
4	31.6	31.4	30.4	29.1	28.6	28.1	35.2	36.7	40.0
4½	33.9	33.7	—	—	—	—	37.8	39.8	43.0
5	36.6	36.5	35.7	34.3	33.6	33.2	41.5	43.0	46.4
6	41.4	41.0	40.7	39.0	38.4	37.9	47.7	49.3	52.5

Single span—one fixed and one free support

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	12.2	12.2	11.65	8.9	8.6	—	11.9	12.25	15.3
¾	14.5	14.55	13.7	12.0	11.2	—	14.1	14.9	18.1
1	17.2	17.25	15.95	14.3	13.7	—	17.3	18.1	21.3
1¼	20.6	20.6	18.9	16.5	16.1	—	20.9	22.0	25.8
1½	22.7	22.7	21.0	18.9	18.4	—	23.2	24.6	28.4
2	26.7	26.7	24.2	23.4	22.8	—	27.6	29.4	33.5
2½	30.6	30.6	27.9	27.6	27.5	26.0	33.5	34.9	38.8
3	35.4	35.2	33.0	31.6	30.8	29.9	39.3	40.3	44.8
3½	38.9	38.8	36.9	35.2	34.6	33.8	43.2	45.1	49.1
4	42.4	42.2	40.7	39.0	38.3	37.6	47.2	49.2	53.6
4½	45.5	45.2	—	—	—	—	50.7	53.4	57.7
5	49.1	49.0	47.8	46.0	45.0	44.5	55.7	57.7	62.2
6	55.5	55.0	54.5	52.3	51.5	50.8	64.0	66.2	70.5

Single span—fixed supports

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	15.55	15.55	14.9	11.4	10.95	—	15.2	15.6	19.5
¾	18.45	18.55	17.45	15.3	14.3	—	17.9	19.0	23.1
1	21.9	22.0	20.4	18.3	17.45	—	22.1	23.1	27.2
1¼	26.3	26.3	24.2	21.0	20.6	—	26.6	28.0	32.8
1½	28.9	28.9	26.9	24.1	23.4	—	29.6	31.3	36.2
2	34.0	34.0	31.0	30.0	29.1	—	35.2	37.4	42.7
2½	39.0	39.0	35.6	35.2	35.1	33.2	42.7	44.5	49.4
3	45.2	44.8	42.1	40.4	39.4	38.2	50.1	51.3	57.1
3½	49.6	49.5	47.1	45.0	44.2	43.2	55.0	57.5	62.5
4	54.0	53.7	52.0	49.8	49.0	48.1	60.2	62.8	68.4
4½	58.0	57.6	—	—	—	—	64.6	68.0	73.5
5	62.6	62.4	61.1	58.7	57.5	56.8	71.0	75.3	79.3
6	70.8	70.2	69.6	66.8	65.8	64.8	81.5	84.3	89.8

Spans, in feet, are for a maximum resultant deflection of 1/150 th of the span. Light load is defined as the resultant of 12 lb per sq ft wind load corresponding to 70 mph and dead weight of bus with no ice.
*Alloy 2S-H18 or 61S-T6.

TABLE 3 — LIMITING SPANS IN FEET WITH HEAVY LOADING

Single span—free supports

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	7.62	7.8	7.1	5.28	5.0	—	7.2	7.35	9.45
¾	9.3	9.5	8.56	7.35	6.8	—	8.8	9.3	11.5
1	11.6	11.5	10.26	9.05	8.56	—	11.05	11.54	14.05
1¼	13.7	13.85	12.3	10.6	10.35	—	13.52	14.2	17.05
1½	15.15	15.5	13.5	12.3	11.9	—	15.35	16.3	19.0
2	18.1	18.45	16.1	15.5	15.0	—	18.25	19.4	22.4
2½	21.1	21.4	18.7	18.4	18.0	17.3	22.3	23.25	26.6
3	24.6	24.7	22.2	22.2	20.8	20.0	26.1	27.3	30.8
3½	27.2	27.3	25.0	24.0	23.5	22.8	29.2	30.5	34.1
4	29.7	29.8	27.6	26.6	26.0	25.5	32.1	33.5	37.2
4½	31.9	32.3	—	—	—	—	34.9	36.4	40.2
5	34.4	34.8	32.9	31.8	31.0	31.1	37.9	39.6	43.6
6	39.0	39.4	37.9	37.0	35.3	34.8	43.6	45.7	49.4

Single span—one fixed and one free support

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	10.2	10.45	9.5	7.1	6.7	—	9.65	9.85	12.65
¾	12.4	12.7	11.5	9.9	9.1	—	11.8	12.45	15.4
1	15.5	15.4	13.7	12.1	11.5	—	14.8	15.5	18.8
1¼	18.4	18.6	16.5	14.2	13.9	—	18.1	19.0	22.8
1½	20.3	20.8	18.1	16.5	15.9	—	20.6	21.8	25.4
2	24.2	24.9	21.6	20.8	20.1	—	24.5	26.0	30.0
2½	28.3	28.7	25.1	24.6	24.2	23.2	29.9	31.2	35.6
3	33.0	33.1	29.8	29.8	27.9	26.8	35.0	36.6	41.3
3½	36.4	36.6	33.5	32.2	31.5	30.6	39.2	40.8	45.7
4	39.8	40.0	37.0	35.7	34.8	34.2	43.0	44.9	49.8
4½	42.7	43.3	—	—	—	—	46.8	48.8	53.8
5	46.1	46.7	44.1	42.7	41.6	41.7	50.8	53.0	58.5
6	52.3	52.8	50.8	49.6	47.3	46.7	58.5	61.3	66.2

Single Span—fixed supports

Tube size, in.	Copper SPS	Copper EHPS	Copper Type B	Copper Type K	Copper Type L	Copper Type M	Alum.* SPS	Alum.* EHPS	Steel SPS
½	13.0	13.3	12.1	9.0	8.6	—	12.3	12.6	16.15
¾	15.9	16.2	14.6	12.6	11.6	—	15.0	15.9	19.7
1	19.8	19.7	17.5	15.5	14.6	—	18.9	19.75	24.0
1¼	23.4	23.7	21.0	18.1	17.7	—	23.2	24.3	29.2
1½	25.9	26.5	23.1	21.0	20.4	—	26.3	27.9	32.5
2	31.0	31.6	27.6	26.5	25.6	—	31.2	33.2	38.3
2½	36.1	36.6	32.0	31.5	30.8	29.6	38.2	39.8	45.5
3	42.1	42.3	38.0	38.0	35.6	34.2	44.7	46.7	52.7
3½	46.5	46.7	42.8	41.0	40.2	39.0	50.0	51.5	58.3
4	50.8	51.0	47.2	45.5	44.5	43.6	54.9	57.3	63.6
4½	54.6	55.3	—	—	—	—	59.7	62.3	68.7
5	58.9	59.5	56.2	54.5	53.0	53.2	64.8	67.8	74.7
6	66.7	67.5	64.9	63.3	60.4	59.5	74.7	78.2	84.5

Spans, in feet, are for a maximum resultant deflection of 1/150 th of the span. Heavy load is defined as the resultant of 8 lb per sq ft wind load corresponding to 55 mph and dead weight of bus with ½ in. radial ice load.
*Alloy 2S-H18 or 61S-T6.

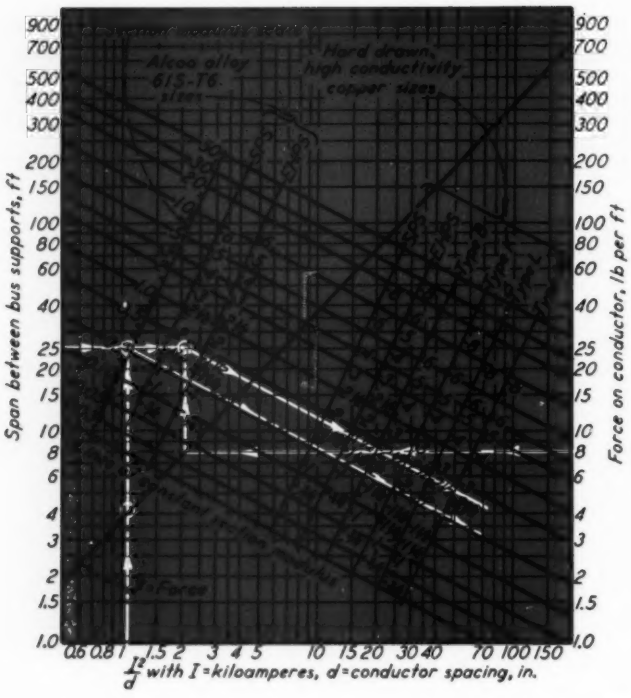

Span between bus supports, ft
Force on conductor, lb per ft
Hard drawn, high conductivity copper sizes
Alcoa alloy 61S-T6 sizes
Force
$\frac{I^2}{d}$ with I=kiloamperes, d=conductor spacing, in.

Fig. 6—By following the example in the text, the chart makes it possible to determine either tube size or span if load (magnetic or other) is known

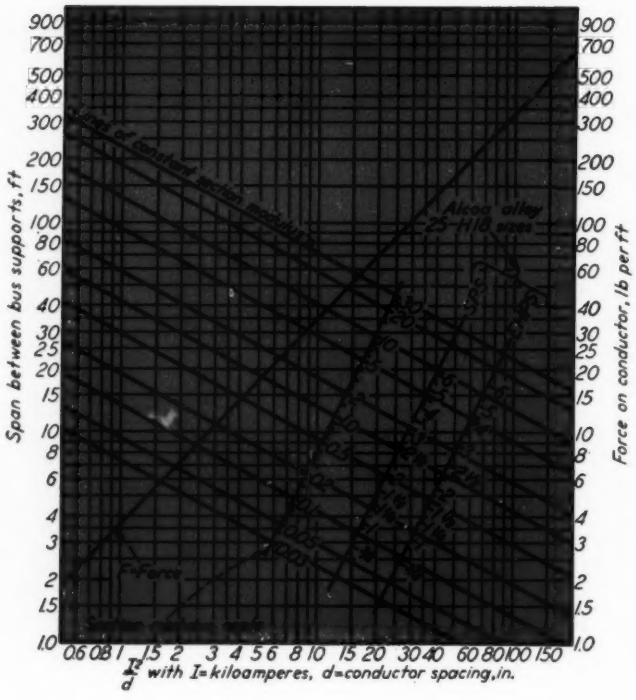

Span between bus supports, ft
Force on conductor, lb per ft
Alcoa alloy 25-H16 sizes
Force
$\frac{I^2}{d}$ with I=kiloamperes, d=conductor spacing, in.

Fig. 7—Where tube sizes in Fig. 6 are for copper and a common high alloy aluminum, the above chart is for the low alloy aluminum materials

circuits are horizontal and may act in the same direction, and should be added directly. However, the resultant of the horizontal and vertical forces must be obtained vectorially by taking the square root of the *square of the total vertical force plus the square of the horizontal force.*

Where short-circuit loading is significant, the resultant force found above should be used to find the limiting span by substituting it for W^1 in the same formulas used in preparing Tables 1, 2 and 3 for tubular buses. These tables were calculated for a maximum dead weight deflection of 1/150 th of span.

The following formulas were used for the tables:

$$L = [3.55\ EJ/1000W^1]^{1/3}$$

for single span with free supports,

$$L = [0.858\ EJ/100W^1]^{1/3}$$

for single span with one fixed and one free support,

$$L = [1.78\ EJ/100W^1]^{1/3}$$

for single span with fixed supports, where

L=length of span in feet

E=modulus of elasticity of conductor (16,000,000 psi for copper, 10,000,000 psi for aluminum)

J=moment of inertia of conductor ($in.^4$)

W^1=load (lb per ft)

Values of moments of inertia for various shapes may be found in handbooks and in manufacturers' catalogs. For tubular bus: $J=.0491\ (d^4—d_1^4)$ where d is the outside and d_1 the inside diameter.

Since size of tubing may have been determined by or a reduction permitted because of span, check current carrying capacity for the size selected above.

Step 5 — Check for Allowable Fiber Stress

Maximum allowable fiber stress for hard drawn, high conductivity copper is 18,000 psi; for aluminum, 10,000 psi, (Alcoa alloy 61S-TS, most commonly used for outdoor tubular buses).

$$L = [PS/1.5W^1]^{1/2}$$

for a single span with free supports and for a single span with one fixed and one free support, and

$$L = [PS/W^1]^{1/2}$$

for a single span with fixed supports, where

L=maximum span between supports in feet

P=fiber stress (use maximum allowable)

S=Section moduls ($in.^3$) of conductors from manufacturers tables or Figs. 6 and 7.

W^1=load (lb per ft)

Use span L obtained in this step or the value obtained in Step 4, whichever is shorter.

Step 6 — Cantilever Stresses at Bus Supports

The cantilever stress at a bus support is determined by the formula:

$$F = W^1L$$

where

F=cantilever force (lb)

W^1=maximum or peak force on condenser (lb per ft) determined in Step 4

L=span (ft)

Cantilever strengths of single unit bus supports will be found in insulator manufacturers' catalogs. If more than one unit is used, the formulas in Figs. 3 and 4 should be used for selecting bus supports.

Provisions must be made to permit free thermal expansion of rigid conductors. Expansion joints or terminals must be used in a span if supports at both ends of the span are fixed. If practicable, one support should be fixed and one should be a slide support.

Spans Determined by Charts

Many calculations may be avoided if the charts in Figs. 6 and 7 are used (see following example). In Fig. 6, forces and spans may be determined for hard drawn, high conductivity copper pipe and tube of extra heavy and other standard sizes, and also for aluminum alloy 61S-T6 in standard and extra heavy pipe sizes. In Fig. 7, forces and spans for buses using aluminum alloy 2S-H18 are plotted.

For an example of cost analysis of a tubular copper bus, assume 100 ft of three phase, 69 kv bus to carry 800 amp and withstand short-circuit forces for rms currents up to 8000 amp.

Assume four bays with 25 ft span (length may be determined by equipment included in the bay). Also assume 60 in. spacing between conductors.

Assume heavy mechanical load conditions (8 lb per sq ft wind load for 55 mph and dead weight of bus with ½ in. radial ice load). For a start, take span equal to length of bays (25 ft) with one fixed and one free support.

From Table 3, satisfactory tube sizes are:

2 in. EHPS (extra heavy pipe size)	24.9 ft
2½ in. SPS (standard pipe size)	28.3 ft
2½ in. EHPS	28.7 ft
2½ in. Type B	25.1 ft
2½ in. Type K	24.6 ft

From tables in manufacturers' catalogs on copper tubing, all of these types and sizes are considerably in excess of current carrying requirements.

Often, many calculations may be avoided by making an economic study next. Check calculations may be then made only on the most economical size and type. For example:

	SPS, 2½ in.	EHPS, 2 in.	EHPS, 2½ in.	Type B, 2½ in.	Type K, 2½ in.
300 ft tubing	$ 935	$ 885	$1350	$ 355	$ 450
15 bus supports	2880	2880	2880	2880	2880
18 bus couplers	350	280	350	350	350
27 A-frame angle tees (1 in. tap)	880	700	880	880	880
3 tees (1 in. tap)	45	36	45	45	45
6 corona bells	24	20	24	24	24
	$5114	$4801	$5529	$4534	$4629

Current capacity of the lightest tube, Type B, is 40 per cent higher than required.

Since the bays are 25 ft long, the ecomomics of using smaller diameter tube with bus supports at 12½ ft intervals might be explored. In this case, 27 bus supports would be required and it becomes immediately apparent that it would not be economical.

Since Type B tubing appears most economical, it is only necessary to use Step 5 to check span limit for fiber stress using resultant force as found later in the chart explanation.

$$L = [PS/1.5W^2]^{1/2} = [18.000 \times 0.42 / 1.5 \times 7.8]^{1/2} = 25.3 \text{ ft}$$

If the answer were less than the 25 ft span assumed, say 23.5 ft, then it would appear advisable either to reduce the bays to 23.5 ft or use the next heavier tubing. However, since the difference would be small, it might be desirable to take the sensible, calculated risk that ice, wind and maximum short-circuit loadings would not all occur at the same time.

Use of Charts — Example

Tables 1, 2 and 3 give limiting spans, taking weight of bus, ice and wind loading into account. Forces due to short circuits are not included because they vary with the application. Due to the large spacing between conductors above 69 kv, short-circuit forces have a very limited effect on design for the higher voltage installations. Figs. 6 and 7 show curves for determining short-circuit forces, the corresponding section modulus (for short-circuit or any other distributed force), and distance between bus supports.

For finding section modulus for any force (in lb per ft) on the charts, the bottom scale may be ignored. Proceed as follows:

From the point on the right hand scale corresponding to the force, draw a horizontal line to the force curve, F. From the intersection, run a vertical line to the coordinate corresponding to the distance between supports on the left hand scale. This latter intersection determines the minimum section modulus. Lines of constant section modulus slope downward to the right and any size or type of tube falling above a parallel line through the intersection will be satisfactory from this standpoint.

The electromagnetic force, 3.73 I^2/d, may be determined from the chart for Step 3, but since I^2/d must be calculated, little is gained there. However, the minimum section modulus corresponding *to this force only* may be found by first evaluating:

$$I^2/d = 8^2/60 = 1.06$$

A vertical line corresponding to this value on the bottom scale intersects the horizontal line for the 25 ft spacing at the 0.2 line of constant section modulus. Tubing types and sizes above the line will satisfy the conditions for short circuits only.

Resultant force and the corresponding section modulus in the preceding examples are found as follows: From handbooks, ½ in. of ice on a 2½ in. bus weighs 1.80 lb per ft, and a wind load at 55 mph is equivalent to 2.4 lb per ft. Dead weight of Type B tubing is 2.6 lb per ft, and short-circuit force as calculated from the formula, $3.73I^2/d$, is 4.0 lb per ft. The resultant of these forces is:

$$F = [(1.8 + 2.6)^2 + (2.4 + 4.0)^2]^{1/2} = 7.8 \text{ lb per ft}$$

Draw a horizontal line from 7.8 on the right hand force scale to the force curve F, then a vertical line to the coordinate corresponding to the 25 ft spacing, resulting in a minimum section modulus of 0.43. This indicates the following tubes would be satisfactory: In aluminum 61S-T6, 2 in. SPS and 1½ in. EHPS; in copper, 2 in. SPS, 1½ in. EHPS, and 2½ in. in Types B, K, L, or M.

consulting engineer

interviews

Dr. Melchior Palyi

consulting economist

Each month, on these pages, Dr. Palyi will answer readers' questions concerning economics and finance. Address questions to: The Editor, CONSULTING ENGINEER, St. Joseph, Michigan

Dr. Palyi interviewed by CE's Editor

Dr. Melchior Palyi was born in Hungary, and educated in Switzerland and Germany, receiving his Doctor's degree from the University of Munich. He has served on the faculties of the Universities of Munich, Goettingen, Kiel, and the Graduate School of Commerce of Berlin. He has been a visiting professor at the University College of Oxford, the University of Chicago, and other colleges in this country.

Dr. Palyi is one of the world's outstanding authorities on economics and finance. He was economist for the Deutsche Bank, in Berlin, and advisor to the Reichsbank from 1931 to 1933. He was at one time director of the Institute for Currency Research, in Berlin, and also served as Foreign Representative of the Hungarian Ministry of Agriculture.

First coming to America in 1926 as visiting professor at the University of Chicago, Dr. Palyi returned here in 1933, to live in this country and become an American citizen. He is well known as a lecturer, financial advisor, author, and radio and television commentator.

Question: What are the prospects of continued industrial expansion in this country for the next two years?

Answer: I would say that the prospects are excellent, especially in all those industries which depend on armament and government orders. Our armament program will expand for at least another year or two.

Question: Is our industrial expansion dependent solely upon armaments and government orders?

Answer: Primarily on those. Of course, nobody can predict what consumers will do. With growing population and inflated currency, total consumer spending is bound to grow. But this growth may not be reflected at once, in the sale of automobiles or homes or domestic equipment so much as, for example, in travel and entertainment—in its broadest sense.

Question: Does this mean that you see a growing market for recreation?

Answer: I think that field is one of the most promising among those which might be termed consumer goods industries. It should be understood that recreation covers everything from outboard motors to locomotives and from fishing rods to bowling balls. Part of this consumer money will go into service industries, but there is no doubt that a great deal of it will go into the manufacture of products for recreation.

Question: Does the consumer have money available to spend on recreation?

Answer: Why certainly. Consumer income is at an all time high and consumer savings are also at a peak. Consumer debt is rising, too—it is at an all time high. Income, savings, and debt keep growing together.

Question: We now have a very tight labor market in this country. To hire a man one company must take him away from a competitor. What effect does this have on labor's productivity?

Answer: An adverse effect. Labor's productivity is rising in many industries, but not because of labor itself. This increased productivity is the result of technological and engineering improvements, research, and new equipment. It is not labor's productivity which is increasing, but capital's productivity.

Question: What logic is there then in the clause in some union contracts which provides for annually increased wages because of what is termed "labor's improved technological efficiency"?

Answer: No logic whatsoever. This is merely a pretext under which the unions exercise their strong, monopolistic bargaining power. I do not object to labor making the most of its bargaining power. I do object to its monopolistic excesses. That is, I object to labor using monopoly powers to claim, under false pretense, a share of company income which it had no part in creating. Labor's price should be determined by supply and demand, like the price of any commodity.

Question: Will there be any easing of the labor market soon?

Answer: The supply of labor is increasing, which should relieve the market. There is a natural population growth in this country which is unprecedented. The important question is not the labor supply, it is the demand for labor. Here again we have two types of demands, the consumer demand and the demand of the government—largely military. The governmental and military requirements for manpower are so great that even if there were a sizable relaxation in consumer demand, the relaxation would have only a moderate effect on the labor market. It would take a major depression in consumer goods to bring about an "employers' market".

Question: Can producers of basic industrial equipment in this country expect an increase in foreign sales?

Answer: The demand of the world, outside the United States and Canada, for manufactured goods is more and more becoming a demand for equipment and less and less a demand for manufactured consumer goods. If there is any future in foreign trade other than in basic commodities, it is essentially in equipment. Most countries want machines and machine tools rather than the final products—which they can produce themselves. This applies particularly to the so-called backward countries which are most anxious to build up their consumer goods industries, and they are looking for the tools with which to do that.

Question: What do the British mean by "trade not aid", which is the motto they have brought with them for economic discussions in Washington?

Answer: By "trade not aid" the British mean "trade and aid". In other words, they want more trade, lower tariff barriers, and generally fewer obstacles to foreign goods entering the United States. In addition they want more aid.

Question: Do they expect a free trade policy by the United States?

Answer: No, they don't expect that. They would, however, like to have the administrative trade barriers eliminated. They do not like the way the tariff is administered. For example, there is practically no time limit set for administrative officials in determining which tariff rates apply to which imports. It sometimes takes weeks and months or years before a decision is reached as to which rates apply to a shipment of imported goods. The American tariff has become so complex, with the rates left to the arbitrary judgment of the bureaucrats, that import business becomes almost impossible. The intent of Congress was to impose certain duties on imports, but it was not the intent of Congress to deal in chicanery —which is what the current setup amounts to.

Question: Is it likely that the current administration will continue to move toward the gradual reduction of tariffs?

Answer: They would probably like to further reduce tariffs. However, our tariff rates have been greatly reduced since 1934. In fact, the rates on 95 per cent of the commodities subject to duties had been cut. The average rate now on all dutiable imports is about 13 per cent, which is higher than in many countries but certainly not exorbitant. There are individual products on which the tariff is very high, but this is the exception. I think, however, it is the mind of the administration to "come across" on tariff reductions as much as possible.

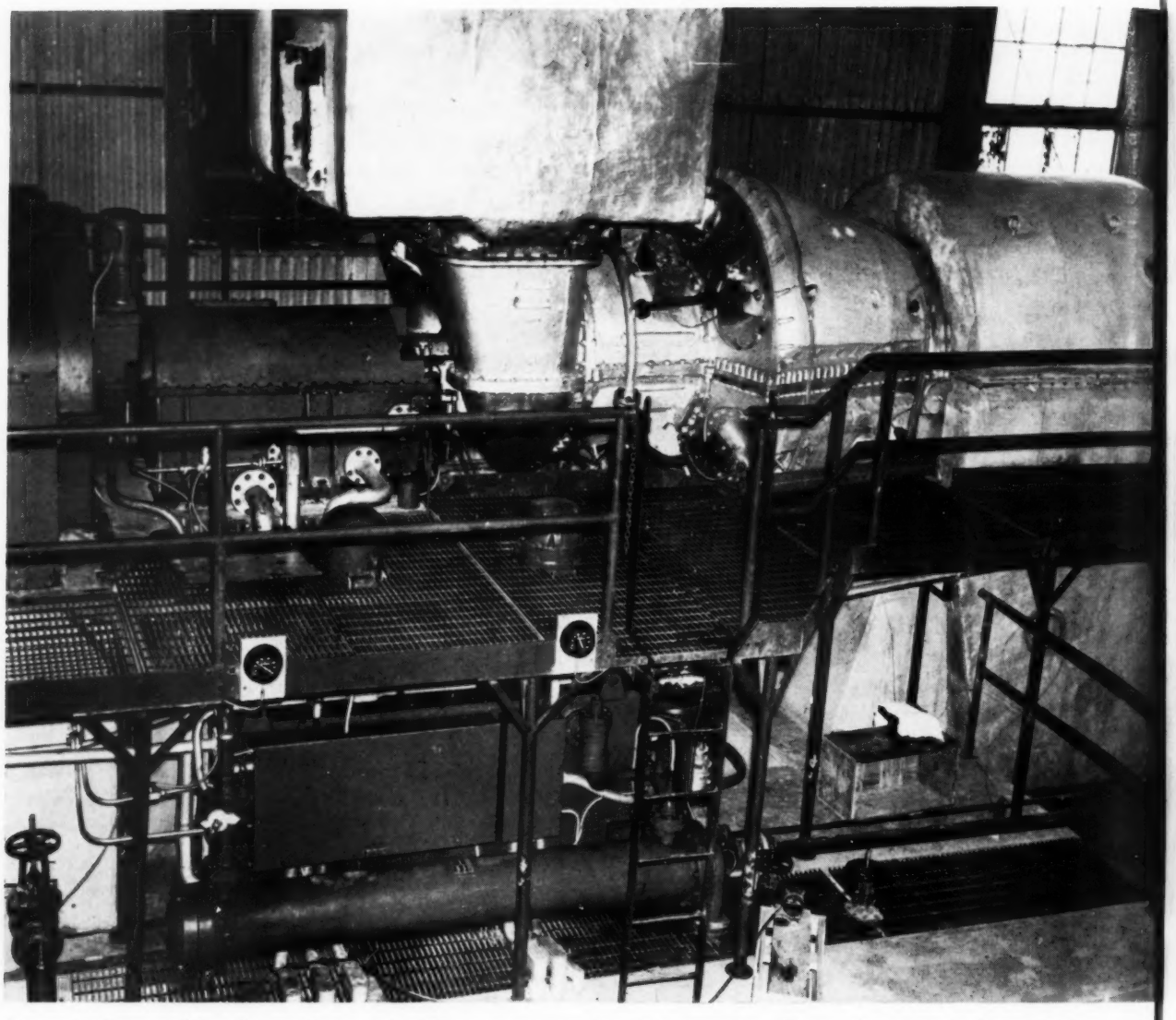
Question: There has been considerable talk around Detroit, that is, the Detroit Chamber of Commerce and then Henry Ford, favoring outright free trade. What is behind this movement?

Answer: The automobile industry cares little for the 10 per cent tariff on foreign automobiles. The little bathtubs on wheels which the Europeans sell here or the $5000 to $10,000 luxury cars are not much competition for Ford or General Motors or Chrysler or any of the American producers. Consequently, they do not need a protective tariff and here is a remarkable instance in which a duty is imposed despite the fact that the protected industry does not want it. It is to their interest to favor free trade.

Besides, the automobile industry is one of the most efficient ones in this country. Very efficient industries are usually not afraid of foreign competition.

Question: The textile industry of the United States is strongly in favor of higher protective tariffs. Is there danger of foreign competition seriously hurting our own textile industry?

Answer: The textile industry is a very complex one. There are absolutely first-rate firms which can stand up under any competition. In fact, since the war, some sections of our textile industry have become world leaders, replacing Britain and Canada to a large extent. In Canada, for example, discriminatory tariffs against American goods in favor of British are in force, but despite this American cotton goods have displaced a large part of the British sales. That indicates that the industry as a whole should not be, and I am sure is not, afraid of foreign competition. There are marginal units in this country that should either be closed down or improved, for they cannot stand the competition of cheaper goods. Much depends on the kind of textiles in question. The higher priced, higher quality goods which we manufacture in this country are not necessarily in danger of serious competition from the low priced, low quality output of Japanese mills or even of European mills, for that matter. And with growing wealth in this country, we are likely to buy less and less of the cheap imported cloth and more and more of the better quality in which American industry often excels.



The use of gas turbines for stationary electric power generation is increasing. Photo shows typical installation

Economics of Power Generation by Gas Turbine Power Plants

C. J. BURKE
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C. J. Burke divided the years of his college career around a period of military service. He entered college in 1941, served in the U. S. Navy Air Corps from 1943 to 1946, and then returned to West Virginia University to complete his education. After graduating in 1948 with a degree in Mechanical Engineering, he was employed by Westinghouse Electric Corp. as an engineer in their Graduate Student Training Program. Early in 1949, Mr. Burke was assigned to the Gas Turbine Section of the Application Engineering Department at the South Philadelphia plant. In this position, he has specialized in the application of gas turbines for a variety of industrial service conditions.

The combustion gas turbine power plant is a practical and economic reality in its present state of development. In fact, gas turbines are doing a better job than other types of competitive power plants for many applications. Doing a better job means the integration and evaluation of its characteristics, such as first cost, operating and maintenance cost, size, reliability, and availability, place it in a more favorable position than other types of power plants. Gas turbines already are competing with and eventually will replace other types of power plants because evaluation will prove them superior.

Commercial gas turbines are available in this country ranging from 1250 to 15,000 kw capacity. Ratings, types of cycles, and characteristics of units now being produced by Westinghouse are outlined in Table 1. As more operating experience is obtained and additional design improvements are made, higher ratings and other types of cycle arrangements will become available.

The various ratings, cycle arrangements, and efficiency levels of the units now available make a study of the economics of power generation by gas turbine power plants worthwhile. This is particularly true as the gas turbine is a new type of prime mover, and many engineers do not have complete information on this method of power generation. Therefore, they do not appreciate fully the present possibilities of using gas turbines to generate low cost power.

To estimate the potential costs of power generation by gas turbines for various applications, it is necessary to assume certain data. Thus, the analyses presented are based on the following assumptions:

1. 1250 kw SOC gas turbine power plant
   a. Total estimated installed cost per kw—$260
   b. Full load heat rate—22,600 Btu per kwhr
2. 3500 kw COCR gas turbine power plant
   a. Total estimated installed cost per kw—$225
   b. Full load heat rate—15,900 Btu per kwhr
3. 5000 kw SOC gas turbine power plant
   a. Total estimated installed cost per kw—$175
   b. Full load heat rate—18,950 Btu per kwhr
4. 15,000 kw COCIR gas turbine power plant
   a. Total estimated installed cost per kw—$215
   b. Full load heat rate—13,500 Btu per kwhr
5. Total fixed charges per year—15 per cent
6. Total cost of operating labor, supervision, supplies, maintenance, and repair—one mil per kwhr
7. The heat rates used are based on the high heat value of natural gas fuel having a ratio of low heat value to high heat value of 0.9. Variation of heat rates with different types of fuels is relatively unimportant in an economic analysis.

In general, power plants can be divided into three principal service classifications, namely: base load, peak load, and standby.

Base Load Plants

The function of a base load plant is to run continuously at full load 24 hours per day, for as many days

TABLE 1 — GENERAL DATA ON WESTINGHOUSE GAS TURBINE PLANTS FOR POWER GENERATION

*Rating, kw	1250	3500	5000	15,000
**Type of cycle	SOC	COCR	SOC	COCIR
***Heat rate, Btu per kwhr	22,600	16,000	18,980	13,580
***Over-all thermal efficiency, per cent	15.1	21.4	18.0	25.2
Turbine inlet temperature, deg F	1250	1350	1350	1350
Plant pressure ratio	4.4	4.0	6.0	8.0
Turbine speed, rpm	8750	6500	5700	3600
Generator speed, rpm	1200	3600	3600	3600
Cooling water required, gpm	140	350	340	4200
Approximate over-all length	29 ft 10 in.	44 ft 11 in.	40 ft 10 in.	96 ft 4 in.
Approximate over-all width	6 ft 6 in.	27 ft 6 in.	13 ft 10 in.	68 ft 7 in.
Approximate over-all height	6 ft 0 in.	22 ft 0 in.	11 ft 3 in.	40 ft 6 in.
Approximate total plant weight, lb	38,000	247,000	94,000	737,000

*Ratings are based on 80 deg F ambient compressor inlet air temperature and 1000 ft elevation or less

**Symbols for cycle types are as follows: SOC — simple open cycle, COCR — compound open cycle with regenerator, COCIR — compound open cycle with intercooler and regenerator

***Values are at generator terminals based on the high heat value of natural gas of 1000 Btu per std cu ft (low heat value of 900 Btu per std cu ft). For distillate oil fuel with high heat value of 19,300 Btu per lb (low heat value of 18,200 Btu per lb) divide heat rate and/or multiply thermal efficiency by 1.048. For residual oil fuel with high heat value of 18,500 Btu per lb (low heat value of 17,400 Btu per lb) divide heat rate and/or multiply thermal efficiency by 1.044

TABLE 2 — COMPARATIVE COSTS OF POWER GENERATION IN MILLS PER KWHR

Part 1 — Base load operation

Load factor	100 per cent					75 per cent				
Fuel cost, cents per million Btu	10	20	30	40	50	10	20	30	40	50
1250 kw SOC plant	7.48	9.73	11.99	14.23	16.54	8.88	11.13	13.39	15.63	17.94
3500 kw COCR plant	6.21	7.82	9.31	11.02	12.59	7.42	9.03	10.62	12.23	13.80
5000 kw SOC plant	5.70	7.62	9.54	11.45	13.30	6.64	8.56	10.48	12.39	14.24
15,000 kw COCIR plant	5.82	7.18	8.53	9.89	11.24	6.98	8.34	9.69	11.05	12.40

Part 2 — Peak load operation

Load factor	50 per cent					25 per cent				
Fuel cost, cents per million Btu	10	20	30	40	50	10	20	30	40	50
1250 kw SOC plant	11.61	13.86	16.12	18.36	20.67	20.55	22.80	25.06	27.30	29.61
3500 kw COCR plant	9.84	11.45	13.04	14.65	16.22	17.59	19.20	20.79	22.40	23.97
5000 kw SOC plant	8.52	10.44	12.36	14.37	16.12	14.57	16.49	18.41	20.32	22.17
15,000 kw COCIR plant	9.30	10.66	12.01	13.37	14.72	16.70	18.06	19.41	20.77	22.12

Part 3 — Standby operation

Load factor	15 per cent					10 per cent				
Fuel cost, cents per million Btu	10	20	30	40	50	10	20	30	40	50
1250 kw SOC plant	32.95	35.20	37.46	39.70	42.01	47.75	50.00	52.26	54.50	56.81
3500 kw COCR plant	28.29	29.90	31.49	33.10	34.67	41.09	42.70	44.29	45.90	47.47
5000 kw SOC plant	22.84	24.76	26.68	28.59	30.44	32.78	34.70	36.62	38.53	40.38
15,000 kw COCIR plant	26.85	28.21	29.56	30.92	32.27	39.15	40.51	41.86	43.22	44.57

per year as possible, with the minimum amount of down time for inspection and maintenance. For this application, the fuel bill, for any type of thermal power plant, becomes the largest single item in the cost of power generation except in very low fuel cost regions. Over-all thermal efficiency, fuel cost, first cost, and reliability are therefore most important factors in the selection of a base load plant.

Tabulated in Part 1 of Table 2, for load factors of 100 and 75 per cent and fuel costs ranging from 10 to 50 cents per million Btu, are the total costs of power generation for the four gas turbine plants outlined in Table 1. The values listed show: (a) for 100 or 75 per cent load factor and fuel cost of 10 cents per million Btu, the 5000 kw simple open cycle gas turbine power plant offers the most economical power generation, and (b) for 100 or 75 per cent load factor and fuel cost of 20 cents per million Btu or greater, the 15,000 kw compound open cycle with intercooler and regenerator gas turbine power plant offers the most economical power generation.

In general, for base load applications with a load factor in the range of 75 to 100 per cent and a fuel cost of 10 cents per million Btu or less, the 5000 kw simple open cycle gas turbine power plant should be selected whenever possible. In higher fuel cost regions, however, the 15,000 kw compound open cycle with intercooler and regenerator gas turbine power plant should receive first consideration. If the application requires less than 5000 kw capacity, the 3500 kw or 1250 kw units should be considered.

Peak Load Plants

A peak load plant operates only during those periods when the base load units cannot handle the load. This may mean regularly scheduled operation, such as 8 or 12 hr per day, or intermittent unscheduled operation during unexpected high peak periods. For this service classification, first cost becomes a more important factor than for a base load plant.

Part 2 of Table 2 lists total costs of power generation for the four plants for load factors of 50 and 25

per cent. This information indicates that for 50 per cent load factor and fuel cost of 20 cents per million Btu or less, and for 25 per cent load factor and fuel cost of 40 cents per million Btu or less, the 5000 kw simple open cycle gas turbine power plant offers the most economical power generation.

For all other peak load operating conditions presented in Part 2, the 15,000 kw compound open cycle with intercooler and regenerator gas turbine power plant should be considered. Of course, selection also will be governed by the load requirements of the specific application.

Standby Plants

Gas turbines for standby service have no regularly scheduled running hours and operate only during emergencies or for unpredictable conditions where it is desirable to have a safeguard. Hydroelectric stations usually require a standby plant to supplement their power in time of low water or freeze-up, and in this case the standby plant may be operated on a seasonal basis. Essential service plants, such as water supply systems, generally demand a standby generating plant to assure operation during failure of their main electric supply.

The load factor of a standby plant may be expected to be quite low. This application requires a low first cost plant with quick starting ability that is simple to operate and easy to maintain. Thermal efficiency is usually a secondary consideration because, for low load factor operation, fuel cost is only a small part of the total cost of power generation.

Total costs of power generation with standby plants for load factors of 15 and 10 per cent are given in Part 3 of Table 2. These figures indicate that for either 15 or 10 per cent load factor and fuel costs up to and including 50 cents per million Btu, the 5000 kw simple open cycle gas turbine power plant offers the most economical power generation.

Economy of Exhaust Heat Utilization

Simple open cycle gas turbine power plants inherently exhaust large quantities of hot gas. For example, the exhausts from the 1250 and 5000 kw plants contain approximately 22,500,000 and 73,000,000 Btu per hr respectively above an ambient temperature of 80 F when operating at full load. It is practical to recover from one-half to two-thirds of this exhaust heat. This heat can be utilized for a number of purposes, such as generating low pressure process steam in a waste heat boiler, heating feedwater, or supplying heat directly to some process operations.

Utilization of the exhaust heat from simple open cycle gas turbine power plants greatly improves the over-all thermal efficiency and increases the number of economically feasible applications. Where low pressure process steam is needed, simple open cycle gas turbine power plants can generate approximately 6 to 8 lb of low pressure steam (under 200 psig) per kwhr when the exhaust gas is utilized in a waste heat boiler. This type of gas turbine application should prove especially attractive to industrial plants where both electric power and large quantities of process steam are required.

Inlet Air Cooling

Gas turbine power plants are rated on the basis of an 80 F compressor inlet air temperature. As a rough rule of thumb, capacity changes five per cent for each 10 F change in inlet air temperature. In regions having high ambient temperature with low relative humidity, an evaporative type inlet air filter washer usually can be justified to maintain high capacity.

Filter washers employ a bank of glass fiber filter pads in conjunction with water sprays to clean, cool, and humidify the inlet air. These units remove impurities and simultaneously cool the air to a temperature approaching the entering wet bulb. Lower entering air temperature increases power output of the gas turbine, and cleaner air supply reduces compressor maintenance. Table 3 gives the approximate makeup and circulating water requirements for cleaning and cooling the entering air for differences of 20, 25, and 30 F between the dry bulb and wet bulb air temperatures.

For applications involving operation at inlet air temperatures below 80 F, the use of an oversize generator, to utilize the additional gas turbine power available, should be considered. As an oversize generator usually adds less than two per cent to the total cost of the gas turbine power plant, its use can be justified economically in most parts of this country.

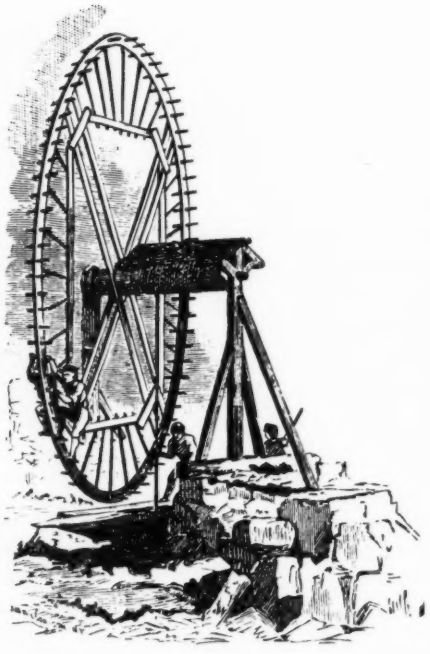
The increasing application of gas turbine power plants provides an indication of the thought being given to economic factors in the selection of equipment for power generation. As more operating experience is obtained and their reliability is demonstrated, gas turbines will supplement, and in many cases replace, present types of prime movers.

TABLE 3 — WATER QUANTITIES REQUIRED* TO CLEAN AND COOL COMPRESSOR INLET AIR

Gas turbine plant rating and operating cycle	*Makeup water, gpm Differential, deg F***			*Circulating water, gpm*
	20	*25*	*30*	
1250 kw SOC	1.2	1.5	2.1	85
3500 kw COCR	3.4	4.3	6.1	250
5000 kw SOC	3.9	5.0	7.2	290
15,000 kw COCIR	10.2	13.0	18.5	760

*Water quantities are approximate, based on cleaning and cooling the compressor inlet air to within 2.5 F of the wet bulb temperature

** Difference between dry and wet bulb air temperatures



Evolution of the elevator can be traced back through the centuries to crude devices such as the slave-powered lift shown above

Another ancestor of the modern elevator is the ancient hoist pictured in a miniature painting found in an early manuscript

Ancient Lifts to Passenger Conveyer Belts

G. B. GUSRAE, Vertical Transportation Consultant
Voorhees Walker Foley & Smith

Gustave B. Gusrae is actively participating in the current revision of the 1937 American Standard Safety Code for Elevators, Dumbwaiters and Escalators. He is a member of the Executive Elevator Code Committee, secretary of the Tests and Inspections Committee, and a member of various elevator code subcommittees. Gusrae was associated with Otis Elevator Co. for eleven years, and has pioneered several important elevator and escalator developments. He is frequently retained as an expert in legal vertical transportation court cases. Since 1947, he has held the position of electrical and vertical transportation consultant for Voorhees Walker Foley & Smith.

Archimedes is credited with designing an early form of lift. The contrivance worked by ropes coiling upon a winding drum rotated by men walking inside a capstan. Such a hoisting lift was constructed in Nero's palace at Rome, and was used for ascending from the Forum to the Imperial Halls.

Lifts based on the winding drum principle were installed in palaces, castles, and monasteries, and some are still in evidence to this day. The Convent of St. Catherine on Mt. Sinai, the Greek monasteries in Thesaly, and the Monastery of St. Barlaam in

Greece all had lifts, usually a basket hoisted by hand to the entrance, perhaps 200 ft above ground. Probably the oldest existing hoisting lift is the one in the Abbey of Mount St. Michel in France, installed in 1203. In this installation, which is still intact, a rope winding drum was powered by a donkey walking within a large tread wheel.

Apparently the art of vertical transportation was in a state of suspended animation through the Middle Ages, for the next chapter begins in the middle of the seventeenth century when a Frenchman, Mr. Villoyer of Paris, invented his "flying chair." The lift consisted of a chair suspended on a rope coiling on a drum and leading to a lead counterweight. The drum was turned by hand. The lift was installed in a hoistway equipped with guide rails. The device apparently had merit, since similar lifts were installed in Windsor Castle for Queen Anne; in the palace of Maria Theresa, Empress of Austria; and at Versailles in Paris, where unfortunately its career was abruptly terminated when the chair became immobilized for several hours. The chair was graced at the time by the king's daughter.

Another Frenchman, Mr. Thronier, improved upon the "flying chair" by operating it from a balcony outside his window instead of in a closed hoistway. Fate was against it, however, for one day the rope broke while Mr. Thronier was enjoying the advantages of his invention.

Power Drives

The first power driven passenger elevator controlled from the car appears to be the "teagle," installed in a factory in England. The *Penny Magazine* of July 25, 1835, describes it as "a belt driven machine operating a counterweighted car equipped with rope controls and designed to carry passengers."

In 1850, both Henry Waterman, of New York City, and the George H. Fox & Co., developed power driven platform hoists designed to carry freight.

Safety Features

Two years later, when Josiah Maise needed a hoist for his bedstead factory in Yonkers, his master mechanic, Elisha Graves Otis, designed and installed the first freight elevator equipped with an automatic device to prevent it from falling. This device was apparently provided in the course of normal events, for in later years his son Charles wrote: "I do not suppose my father had the slightest conception at that time of what the outcome of his invention was to be."

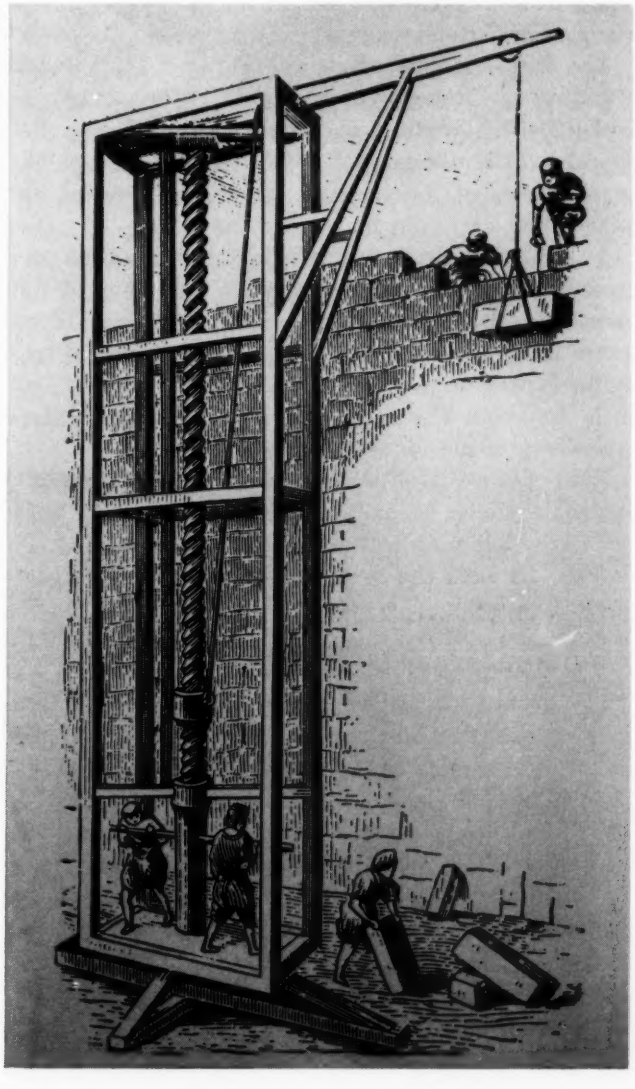
In 1853, Mr. Newhouse, a furniture manufacturer, asked Otis to build two "safety" freight elevators for his factory. Otis took over the first floor of the then bankrupt bedstead factory at Yonkers, site of the present Otis plant, and found himself in the elevator business. Although he exhausted his funds and credit, he managed to exhibit his elevator at the Crystal Palace Exposition in 1853. The *New York Tribune* report of that era reads: "We may commence by referring to an elevator or machine for hoisting goods exhibited by E. G. Otis of Yonkers—which attracts attention both by its prominent position and by the apparent daring of the inventor, who as he rides up and down the platform occasionally cuts the rope by which it is supported."

In 1857, Otis installed the first safe passenger elevator in the china-and-glass store of E. V. Haughwout, New York City. At the time of his death, four years later, Otis was the owner of a small factory employing ten men.

New Types

About the same time other types of elevator machines were being designed along the lines of vertical telescopic plungers and large direct driven screws which passed through the center of the car. The vertical screw railway built in 1859 by Otis Tufts, and the Miller Screw Machine designed in 1867,

This early hoist can be described as a prototype of the modern jackscrew combined with a simple rope and pulley



belong to this type. The *New York Herald* describes the Tufts installation in the Fifth Avenue Hotel in New York as follows: "Perhaps the most powerful feature of the accommodations is a vertical railway—that is a carriage which will move from the top to the bottom of the building and from the bottom to the top. The car stops at each floor and passengers are landed and taken in. In the same way in making the descent it stops at each floor. Near the vertical railway there is a capacious staircase for those who prefer using their legs."

In 1880, a water balance elevator was installed in the Western Union Building. Its design included a large bucket suspended on a rope passing over a sheave to the elevator car below. The water bucket and the car traveled in separate hoistways, and the bucket was filled or emptied by the car attendant as required for ascending or descending. A brake was provided for stopping.

In 1872, Hale Elevator Co. and Otis Brothers & Co. jointly developed the vertical cylinder type, geared hydraulic elevator. At the same time, Whittier Machine Co. developed the horizontal cylinder type, and Prof. G. I. Alden of Worcester Polytechnic Institute further improved the direct plunger machine. These designs permitted car speeds up to 800 fpm for structures 25 floors or more.

The first 12 story-and-attic skyscraper, the Tacoma Building in Chicago, completed in 1888, was equipped with five vertical cylinder hydraulic elevators. The World Building in New York City, completed in 1889, and at the time the tallest building in the world, had ten such hydraulic elevators.

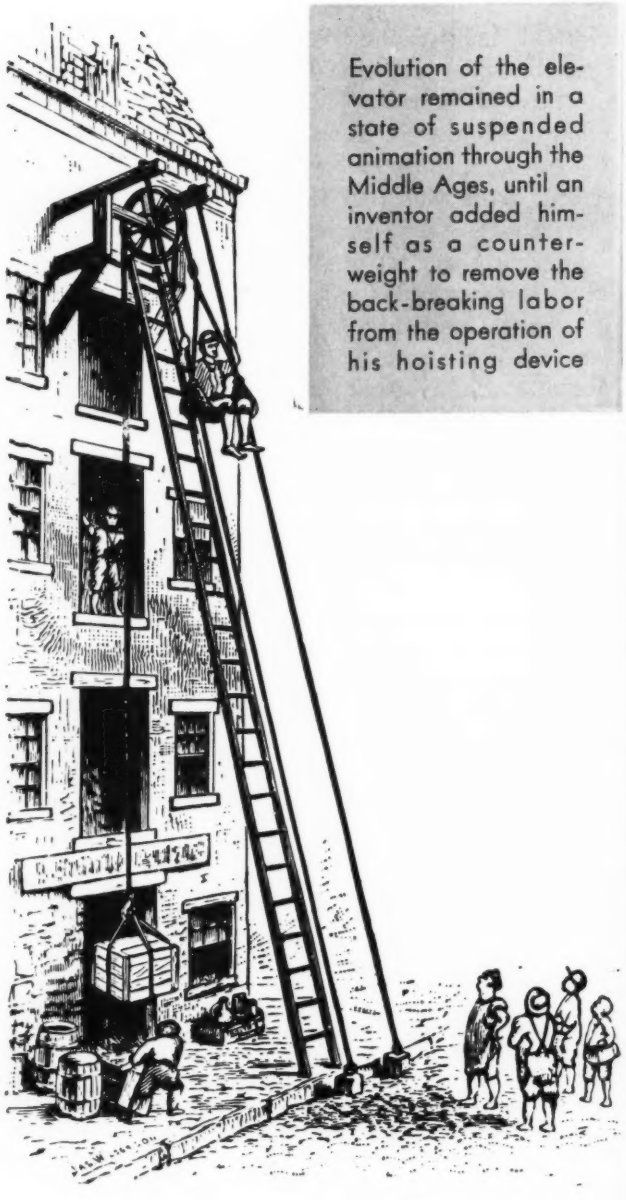
In 1889, Otis Brothers & Co. installed the first successful geared drum type, electric elevators in the Demarest Building in New York City, and three years later H. Ward Leonard designed an electric motor control known today as variable voltage control. At about the same time the first push button type elevator was developed and installed.

Next, Charles D. Seeberger developed the moving stairway, which he called an escalator, and in 1898 the first such unit was set up at the Otis Yonkers Works. In 1900 the escalator was exhibited at the Paris Exhibition.

Refinements

The march of progress continued. In 1911 the traction principle was applied to single wrap geared elevators. In 1915 automatic leveling was added. Then improved signals, power door operators, and a long list of safety devices and refinements were developed. In 1921 the first edition of the Safety Code for Elevators, prepared by an ASME Committee on Protection of Industrial Workers, was published.

In 1922, the Westinghouse Electric Corp. installed the first variable voltage control elevators in the Chicago Athletic Club. Signal control and the "high call reversal" were developed soon afterwards, so



Evolution of the elevator remained in a state of suspended animation through the Middle Ages, until an inventor added himself as a counterweight to remove the back-breaking labor from the operation of his hoisting device

that by 1929 when the four tallest buildings in the world were started[1], the elevator industry was prepared to provide adequate vertical transportation.

Today

Vertical transportation of today is far removed from the simple contrivances of yesterday. Although no implication is intended that perfection has been reached, modern equipment as measured by present requirements, is reasonably satisfactory.

Today, about one-quarter million elevators in the United States carry approximately 25 billion passengers some 500 million passenger miles per year, or five times the passenger mileage of the nation's class A railroads. This has been accomplished at the lowest accident rate in the transportation industry: one injury for every 40 million passengers carried. How

[1]The Bank of Manhattan, 71 floors, 927 ft; 60 Wall Street, 66 floors, 950 ft; Chrysler Building, 77 floors, 1046 ft; and Empire State Building, 102 floors, 1250 ft.

vital vertical transportation has become to our mode of life has been emphasized by the recent strikes of elevator attendants.

Heavy and varied demands of our civilization upon vertical transportation have created quite a family. The freight branch offers dumbwaiters; moving loading platforms; sidewalk elevators; and freight elevators of any platform size within practical limits, at any legal speed, for any load up to several hundred thousand pounds.

The passenger branch offers elevators for private residences, apartment houses, office buildings, hospitals, and department stores, as well as moving stairways having rated capacities up to 8000 persons per hour. To this family belong bank teller cage elevators for carrying payroll cash; sumptuous elevators such as the one in Zlin, Czechoslovakia, used by Jan Bata, the shoe manufacturer, as his private office[2]; and those built by King Ibn Saud of Saudi Arabia for the visit of King Farouk of Egypt.

The vertical conveyer branch of the family offers a variety of book, document, mail, or specimen carrying conveyers which automatically discharge the load at desired points and are available at each floor for loading whenever required.

Controls

Motor speed controls range from relatively simple resistance types to more complicated electronic, variable voltage controls, designed to provide extremely smooth acceleration, deceleration, and stops.

[2]In the new offices of Springs Cotton Mills, Ft. Mill, S. C., a hydraulic lift raises a large section of floor to the level of Col. Spring's desk, so that what was merely a desk a moment before, becomes a large conference table at the push of a button.

Controls for elevator operation vary from the simple car switch, requiring constant button pressure, to the latest electronic signal control operation, either with attendant or operatorless. Electronic controls can have an excellent memory for retention of groups of varied instructions, and a time sense for recognition of the desired sequence required in carrying out instructions. Further than that, for some types of operation they have been given a capacity for freedom of choice and a conscience.

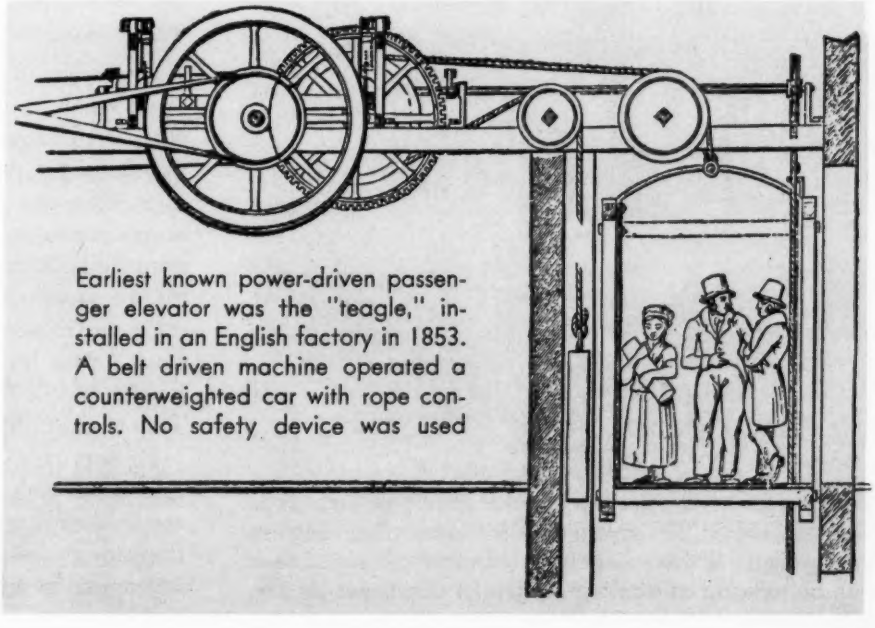
For instance, in a bank of elevators where different cars operate in different building zones, one car may have completed the task within its zone and may then have a choice of taking its earned rest period or extending a helping hand to adjoining overworked neighbors. Prodded by its electro-mechanical conscience and subsequent electronic guilt feeling, it will forego the rest period and rush to aid its neighbors in a zone normally not assigned to it.

Day by day, new ingredients simulating human reactions, behavior, and thinking are being incorporated in vertical transportation equipment to obtain human-like responses and service without the poverty of human shortcomings.

Safety

Equipment has been made as safe as humanly possible. The constant battle of wits waged between those insistent upon breaking their necks and engineers who do their best to prevent it, has resulted in a large number of safety devices. The Elevator Code, first published in 1921 and last revised in 1945 as the American Standard Safety Code for Elevators, Dumbwaiters and Escalators, has included new rules

E. G. Otis, inventor of the first automatic device to prevent elevators from falling, exhibited a freight elevator at the Crystal Palace Exposition in 1853. He was described as daring when he demonstrated his invention by cutting the elevator's supporting ropes



Earliest known power-driven passenger elevator was the "teagle," installed in an English factory in 1853. A belt driven machine operated a counterweighted car with rope controls. No safety device was used

and provisions with every revision, designed to prevent recurrence of accidents.

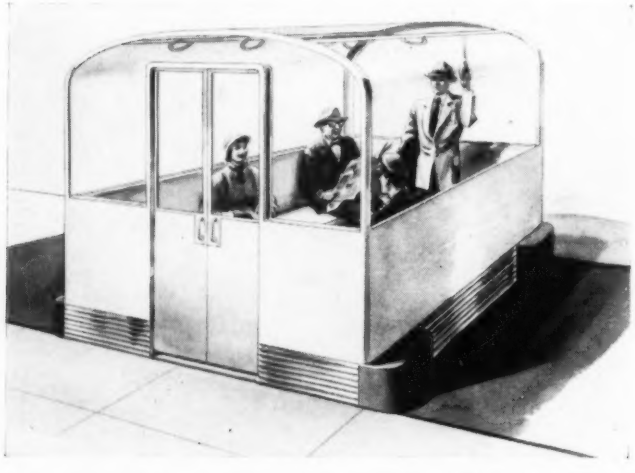
Included among the safety devices is a buffer in the pit, designed to absorb kinetic energy of the car in the event of its fall at the rate of normal speed. A mechanical safety stops the car in the event of overspeed, and stopping devices at top and bottom prevent an overrun beyond terminal landings. Additional safety is provided by a device which prevents the car from leaving the landing when overloaded.

An interlock on each hoistway door and a contact on the car door prevent the car from leaving the landing before the doors are fully closed. In addition, on automatic doors, a safety shoe causes the door to retract if it touches any object while closing. Other safety devices include an emergency stop button and automatic leveling. Dumbwaiters, escalators, and vertical conveyers are similarly equipped with an array of safety devices to prevent accidents.

In addition to obvious safety devices, a number of hidden provisions are incorporated in the design of the equipment itself. For instance, the brake is mechanically held and electrically released so that it always operates to brake the machine in event of power failure. The governor clutch jaw mechanism is so designed that neither rust nor accumulation of dust or grit will interfere with its operation.

Were a downward moving elevator car to stop suddenly, the counterweight would jump a considerable distance. As an example, a car stopping suddenly from a speed of 1000 fpm would cause an upward counterweight jump of about 4½ ft, resulting in a severe shock on the car and hoisting ropes. To prevent occurrence of such shock, the mechanical safety on the car is designed to stop the car through a slide equal to the anticipated counterweight jump.

Steel guide rails are fastened to the building in such a manner that the building steel is free to settle without causing rail compression and subsequent buckling. Special safety provisions are used in equipment installed on ships to prevent whip of hoisting ropes and to withstand severe alternating forces acting on the car frame and guide rails due to lurching of the ship. This also applies to equipment installed in tall steel towers, 1000 ft or more in height, which are often subject to swaying.



For a proposed conveyer system to replace New York City's 42nd St. shuttle, Goodyear Tire & Rubber Co. visualizes cars which will ride on a track of moving belts. Speed can be reduced at platforms to permit continuous loading

Chicago Museum of Science and Industry visitors compare today with yesterday when they ride the world's first moving rubber sidewalk at the B. F. Goodrich exhibit

This is vertical transportation of today. It is varied enough and flexible enough to satisfy practically all needs of modern man. It is safe when used and maintained properly. It is satisfactory today—what then of tomorrow?

Tomorrow

Evolution of the elevator from the old cumbersome winch type to the modern high speed, electronically controlled, streamlined machine was brought about by the demand for increasingly higher buildings. This era appears to be over, and with its disappearance the need for higher speed elevators has vanished. Many businesses are moving into areas where space is relatively abundant and where buildings can expand horizontally. Under such conditions, office buildings seldom exceed five stories in height and 400 ft long corridors are not uncommon. This trend is likely to increase in the near future.

Tomorrow's elevator will adjust itself to the trend. It will become quieter and smoother, and will operate at slower speeds. Automatic leveling will be further improved. Developments in micro-wave radio transmission will be applied to elevator signals, elim-

inating signal wiring in the hoistway. Automatic operation will become practically universal, and additional safety devices will insure safe self-service operation. New elevator design, other than the basement machine type, will be developed to satisfy architects' demands for elimination of the penthouse which is noticeable on low rise buildings and, from the architectural point of view, is considered unsightly. For this purpose, and in competition with the plunger type elevator which does not require a penthouse, the vertical, electrically driven screw type elevator may be redesigned using modern materials and methods. As an alternate, the machine room may be relocated to the side of the hoistway.

It is doubtful whether the elevator will soon undergo any revolutionary changes. It is almost a certainty, however, that if the trend toward low rise, horizontally expanded buildings increases, the role of the passenger carrying elevator will be taken over by moving stairways, and the elevator will be relegated to the less glamorous but very useful position of the work horse of vertical transportation—the freight elevator.

Moving stairways, ideally suited to low rise, highly populated business buildings, will be used in ever larger quantities. New designs, most likely of lesser width with simpler mechanism, will be developed to further decrease cost. New balustrade finishes will be developed to avoid distracting reflections. Equipment will be made safer, quieter, and smoother in operation. A greater inclination angle may be used, or a spiral stairway unit may be designed to reduce the space required. A system of express and local stairways will be used for improved operation. Linear speed will be increased to at least 150 and possibly 200 fpm. Units for certain floor heights, as agreed upon by industry, may be standardized and practically packaged.

Moving Belts

Vertically expanding buildings of the 30's created a demand for properly designed components of vertical transportation. The horizontally expanding buildings of tomorrow will create a demand for a new form of horizontal transportation—moving belt platforms. Such moving platforms will carry passengers along the long corridors to their destination, permitting servicing of such buildings with only one riser of moving stairways. One can visualize them as a continuous belt traveling along the first floor corridor, up to the second floor and so on, until it returns to the first floor. Synchronized driving motors would be provided at each floor. Two such belts will be required, traveling in opposite directions.

The moving chairs installed by Westinghouse for the General Motors Futurama at the World's Fair in New York in 1939-40, are a forerunner of the horizontal belt transportation yet to come.

New Facility Will Produce Zirconium

One of the more interesting technical developments resulting from the atomic research program is that of the commercial production of zirconium, a long known but little used metal. As a material required for the construction of a submarine nuclear reactor, it has taken on a role of major importance.

It has remarkable corrosion-resistance, an extremely high melting point, and is a good structural material in that it is quite strong and workable. Most important for nuclear reactors is the fact that it does not "waste" neutrons, whereas some metals absorb them and thus interfere with atomic fission.

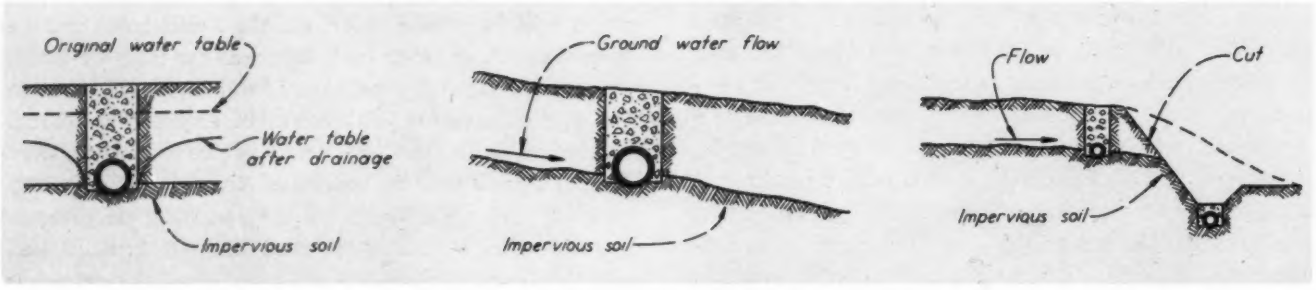
Zirconium was discovered in 1789, and several different processes to produce the metal were developed, but only to a point where small quantities could be produced at high cost. Purity is of prime importance, since in its impure state the metal is brittle, unworkable, corrodible, and in some forms even dangerously inflammable.

Research to find processes by which zirconium can be produced in larger quantities first gained impetus about four years ago. Work first began at the Bureau of Mines in Albany, Oregon, and since that time has been supplemented by many AEC laboratories and contractors.

The first commercial production of zirconium started in 1950, when Westinghouse Electric Corp. began refining the metal for use in their submarine nuclear reactor research. The refining process was required to remove impurities from zirconium sponge, a porous form of the metal received from the Bureau of Mines. This plant boosted production of the pure metal from several hundred pounds to thousands of pounds per month. Further research has developed ways of using the cheaper zirconium sponge, however, and operation of the original Westinghouse pilot plant is no longer necessary.

Rust Process Design Co. reports that a 2½ million dollar plant is being designed and constructed for the Carborundum Metals Co., Inc. The latter company, a new subsidiary of Carborundum Co., recently signed a five year contract with the Atomic Energy Commission for delivery of 150,000 lb of zirconium and hafnium sponge metals per year, at a unit price of less than $15.00 per lb.

Zircon sands, obtained from the beaches of Florida, will be heat treated in an electric furnace to make carbide. This phase will be handled by the parent Carborundum Co., in existing facilities. Processing of the carbide will then be carried out in the new plant, which is scheduled to begin production in July of this year. The process consists of converting the carbide to a chloride, and then through purification, to zirconium and hafnium sponge metal.



To lower the water table the tile is laid just below the desired water level

Subdrains intercept ground water that flows down an impervious soil stratum

Road cuts that expose an impervious stratum call for an interceptor tile

When the Subsurface is Unstable
The Only Cure is Drainage

D. M. STRICKLAND

D. M. Strickland is president of the National Clay Pipe Manufacturers Association. He is a chemical engineer and has a long association with the vitrified clay pipe industry. Mr. Strickland has also served with Southern Clay Pipe and NCPMI for many years.

If pavement or other surfacing is to stand up under the heavy continuous traffic of the day, it should be laid on a firm, unyielding subgrade. This is an elementary fact, yet insufficient attention has been given to the conditions under which such subgrades maintain their stability.

Much has been published recently about soil stabilization, yet, only where physical characteristics of the soil are responsible for the instability can the addition of calcium chloride, cements, and bituminous substances prove to be permanently beneficial. Soil stabilization in this sense means treatment and strengthening of only the subgrade surface or the top two or three inches. When the foundation on which this surface is to be supported is unstable, due to a wet or spongy subgrade, the stabilized surfacing will fail to stand up.

Under such conditions the one sure cure is drainage, which either carries away surface water before it percolates into the subgrade, or removes the water as rapidly as it percolates into the subgrade.

Kinds of Drainage Systems

Drainage systems in general are of two types:

1. Surface drainage, which consists of longitudinal ditches and gutters for the collection of water, culverts and bridges for conveying it through embankments, and sometimes a pipe system for disposal of the collected water.

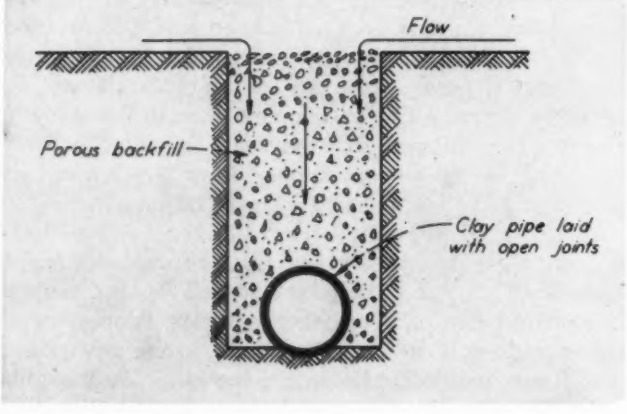
2. Subsurface drainage, which employs pipes or stone filled trenches to collect subsoil water and provide for its removal.

STORM AND SURFACE DRAINAGE

Surface drainage systems are designed to remove water from the surface area before it has a chance to become percolating or ground water.

Interceptor Drains

Good practice calls for laying interceptor drains along surfaced areas to collect surface water before it floods the area. Standing water can percolate into the subsoil and imperil the stability of pavement or other surfacing. In some places intercepting drains are also needed on the upper side of a runway or highway to prevent inundation of the surface.



Typical interceptor drain shows the porous backfill. Either regular or perforated clay pipe can be laid

There are several types of interceptor drains in use today, such as stone backfilled trenches, catch basins, shallow gutters, or continuous open gratings.

Porous Backfilled Trench

Clay pipe (with or without perforations) is properly laid with unsealed joints on the bottom of a trench. The trench is then carefully backfilled to the surface with a porous material, such as stone. Surface water flows to the trench by gravity, percolates through the coarse backfill and enters the pipe.

Continued perviousness of backfills cannot be relied upon under all conditions. There is always risk of the voids filling with fine soil. To help prevent this, special filters of graded backfill materials are sometimes used. Starting with a coarse material at the bottom of the trench, each layer is progressively finer as the backfill approaches the surface.

But, even with this precaution, the runoff over certain types of soils will carry enough silt into the trench to slow down or prevent percolation through the backfill. One factor, which must be taken into consideration, is the situation of a large quantity of storm water that must be quickly drained off a surface area. Also, in northern climates ice and snow can completely block drainage through porous backfills.

Inlets and Catch Basins

Conventional inlets or catch basins with grated covers installed flush with the surface are preferred construction. They are placed at regular intervals along the surfaced areas, and at low points in unsurfaced areas where the runoff is expected to be heavy.

Distance Between Drains and Inlets

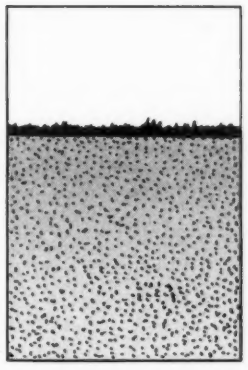
In general, the design of surface drains depends upon the depth of water allowable over the area under the storm conditions, which are selected to govern the design. Selection of a constant distance between drains simplifies computations and introduces no appreciable disadvantages in most problems. An interval of 200 to 300 ft between inlets will usually be found satisfactory, although the spacing is dependent primarily on economic and hydraulic factors and may be varied to suit a particular situation.

Capacity and Size of Drains

Rainfall-frequency to be used for design purposes will depend upon the nuisance value of flooding of the area under consideration. Where even infrequent flooding would be harmful, design must be based upon maximum precipitation to be expected at any time. Where occasional flooding would not imperil safety or damage the facilities a shorter rainfall-frequency can be selected.

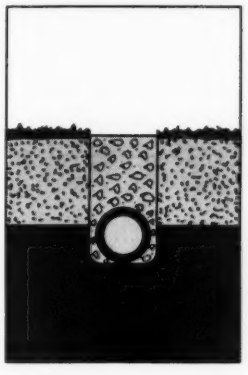
Surface or storm drains may be employed also as outlets for the water collected by the subsurface drainage system. When designing dual purpose storm drains, sizing them to carry subsurface and surface water simultaneously is not necessary be-

Five major classifications of soil structure are illustrated and explained in this column

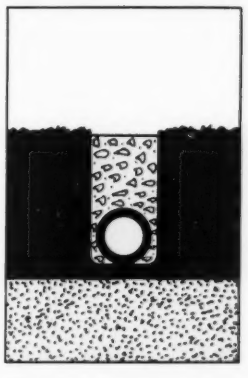


Uniform and pervious soils permit water to pass through them fairly quickly and require little or no subdrainage whatsoever

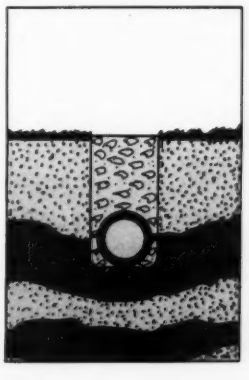
Uniform and impervious soils do not readily permit water to pass through. Rainfall forms in pools on the surface, and most of it either runs off over the surface or evaporates. Only a small part is soaked up by the earth. This soil requires surface drainage



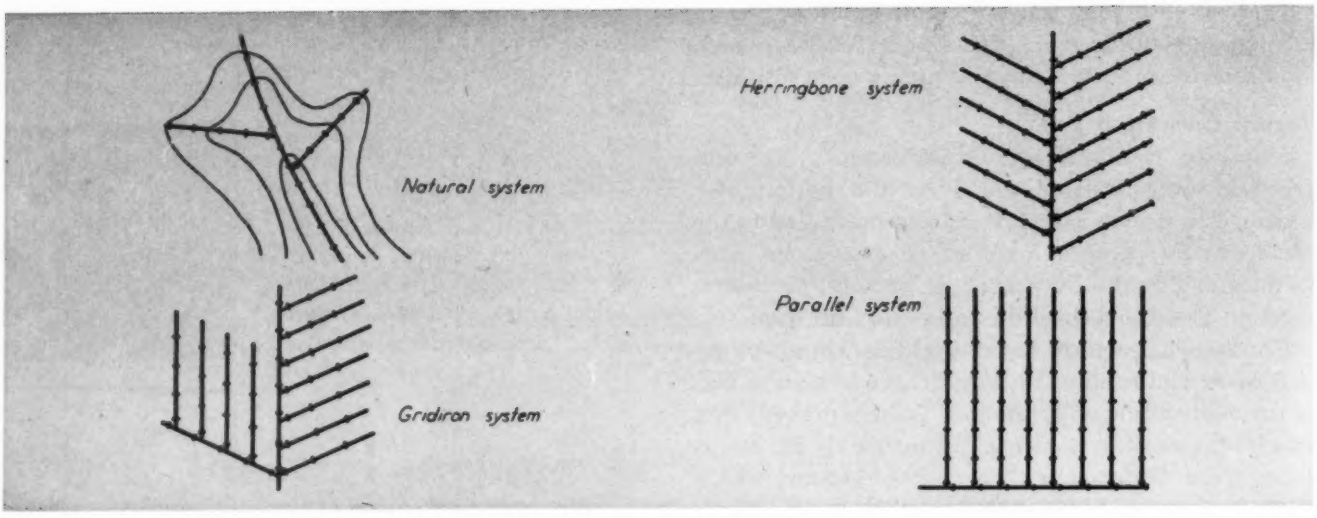
With a pervious layer above and an impervious layer below, the water passes through the top layers and collects on the dense stratum below. Here it forms a layer of unstable, water saturated soil. If the impervious layer is near the surface it may be necessary to drain off the water which collects above



With an impervious layer above and pervious layer below, water must be collected on the surface and trenched through the impervious layer. This permits water to percolate into the coarser material beneath. Where the pervious layer is deep a drain can be provided to collect the surface water



Irregular strata of impervious and pervious soil usually result in water pockets between the strata. Test holes are necessary to determine the depth of pocket, and a drain system designed to collect the water



Layout patterns of subdrainage systems are illustrated above. Natural system follows topography of the surface and acts as a stream. Main branch of herringbone system follows a valley. Other two systems are for flat surface

cause the peak load of surface storm water usually passes before the ground water reaches the drains by percolation.

SUBSURFACE DRAINAGE

As previously explained, part of the rainfall seeps into the soil. The amount is controlled by such factors as the perviousness of the earth and the slope of the surface. What happens to percolating water depends upon type of soil and stratification of subgrade.

There are five major classifications of soil structure, and each has its own drainage problem. Test borings made at frequent intervals over the area to be drained will determine the subsoil structure. The findings should be indicated on the drainage profiles and cross sections. With these data the best drainage design for each section of the area can be determined. Such explorations will determine whether the water table is close enough to the surface to imperil the stability of the surface or to contribute to frost heaves.

Impervious layers in the soil often trap subsurface waters and form layers of water-soaked earth that can do enormous harm. Fills on such ground often sink or shift. Capillary action causes the water from the saturated soil to penetrate the fill, further aggravating the trouble by causing slides and cave-ins.

Water tables are not necessarily level or constant, and the fall of a few inches of rain may raise the water table several feet.

Capillary Water Causes Frost Heave

Water rises in fine soils by capillary action and the rise in some soils is unbelievably great. This capillary water in silts or silty sands freezes and causes frost heaving. Frost penetrating the surface freezes the capillary water immediately under the surface, but does not go deep enough to stop all capillary motion. Additional water, therefore, rises and feeds the ice crystals near the surface, causing them to expand further. Finally a time is reached when the upward thrust of the expanding ice particles becomes so great that the surface erupts.

Frost blisters may reach one foot or more in height and may extend for a diameter of 40 ft or more. After the frost leaves the ground, the water from the melted ice softens the subgrade, and the boil caves in with resulting damage to the surfacing.

Capillary water cannot be drained from the soil. It can be controlled only by lowering the water table. A properly designed subdrainage system will keep the water table below the trouble level.

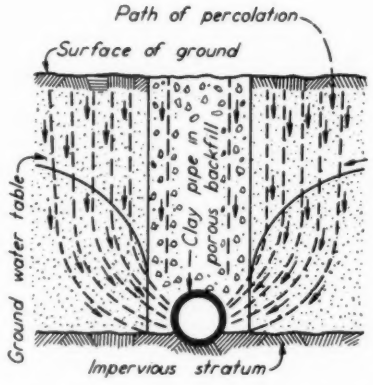
Design of Subdrainage

In designing a subdrainage system for the purpose of intercepting seepage water or lowering a high ground water table there are several factors that must be considered. Soil texture must be studied to determine whether subdrainage will be effective in a reasonable length of time. Size, depth, and spacing of drains and type of backfill must be chosen.

Where there is doubt as to whether or not drainage may be practicable, two factors must be considered before making a decision. Permeability affects the drainage of a soil by limiting the rate at which free water will flow to the drain, and capillary characteristics will affect soil drainage by limiting the amount of water subdrainage can remove.

Size and Spacing of Subdrains

Soils that contain more than 70 per cent clay are difficult to drain. Frictional resistance to flow increases rapidly with decrease in the sizes of soil pores. Drain spacing also has a pronounced effect upon the rate at which the water between the drains is lowered. For wider spacings, the time required to



Path of the ground water to a clay pipe subdrain under normal conditions

TABLE I — SPACING AND DEPTH OF SUBDRAINS IN SOILS OF VARIOUS COMPOSITIONS

Type of soil	Fine gravel and sand	Silt	Clay	Recommended depth of trench in feet	Recommended distance between drains, in feet
Sand	More than 20%	0-15%	0-10%	5-6	150-300
		Less than 20%			
Sandy loam	More than 20%	10-35%	5-15%	3½-4	100-125
		More than 20% and less than 50%			
Fine sandy loam	Less than 20%	10-35%	5-15%	3½	100-125
		More than 20% and less than 50%			
Loam		0-55%	15-25%	4	50-100
		More than 50%			
Clay loam		25-55%	25-35%	3-4	35-60
		More than 50%			
Clay			35-100%	3-4	25-50
			More than 60%		

produce a certain amount of drainage is considerably longer than for more closely spaced drains.

There is an advantage also in placing subdrains deep. Due to the higher heads of water on the lower drains, the rate of discharge is greater than for those of drains installed at lesser depths. However, economic factors and engineering limitations restrict the depth to which subdrains may be placed.

Size of a subdrain has an effect upon its ability to remove ground water. Size not only affects the amount of water a subdrain will carry, but the pipe circumference also determines its capacity for admitting water from the surrounding soil. When the backfill material over and around the subdrain is pervious, the trench width may be considered as being the true drain diameter. However, if the backfill material is not highly pervious, it is good practice to consider the pipe diameter as the drain diameter.

Design Characteristics

Where water is collecting near the surface on a substratum of impervious soil material, subdrains are laid in a porous backfill slightly below the level of the impervious soil. Such construction provides an outlet for the trapped water.

Where the drainage system is designed to lower the water table only, the pipe is laid at a level below the desired water level. Pipe depth necessary to lower the water table to a given level will depend upon the distance between subdrains in the area and type of soil. To determine the depths and spacings of subdrains for such a drainage layout see Table 1.

In some instances the impervious stratum in the soil is not level, and water that accumulates on top of the stratum flows slowly down grade to accumulate in low spots. Good subdrainage design calls for installing subdrains to trap such ground water before locations are reached where it might soften the subgrade or do other damage.

When grading, cuts are sometimes made into impervious layers, and they can be exposed. Water moving over these strata will come to the surface at such points and cause wet spots. Subdrains should be built to catch such ground water before it reaches the surface or causes trouble.

Subdrain Layout

Where plans call for removal of ground water, which is trapped on top of impervious stratum or lowering the water table, a comprehensive system of subdrains is installed. Depth, distance apart, and

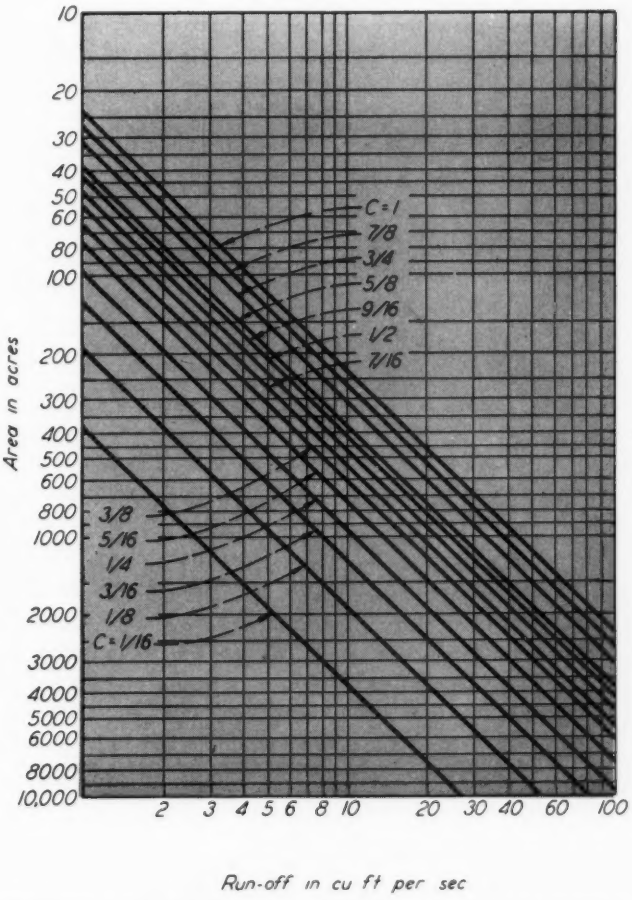
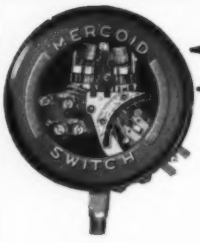


Diagram for determining the required drainage to remove various depths of water in inches (C) in a 24 hr period

ONE CONTROL DOES THE JOB OF TWO



DA-400

Mercoid DA-400 Series Pressure Controls incorporate a single bourdon tube which actuates two independently adjustable Mercoid magnet operated mercury switches to accomplish various circuit operations. For example:

1. Close one alarm circuit at high pressure and another at low pressure with both circuits open over operating range.
2. As an electrical interlock to open one circuit as pressure rises above and the second circuit as the pressure drops below operating range.
3. To provide two-stage control by opening or closing one circuit on a rise in pressure and the second circuit on a further rise in pressure.

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Equipped with calibrated dial and outside adjustments—Ranges 0-30 psi to 300-2500 psi—The Mercoid magnet operated mercury switches are not affected by harmful effects of dust, dirt, or corrosion—your assurance of millions of operations.

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B-I-F INDUSTRIES INDEX OF PRODUCTS

Send today for your copy of this convenient reference Bulletin B-I-F 3 — the complete index of products manufactured by %Proportioneers, Inc.%, Omega Machine Company, and Builders-Providence, Inc. Contains 72 main product divisions. Gives brief descriptions of the proportioning pumps, dry and liquid feeders, and instruments and controllers manufactured by these three companies. Index lists complete line of Bulletins available for detailed information.

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B-I-F INDUSTRIES

B-I-F Industries, 512 Harris Ave., Providence 1, Rhode Island

general pattern of the drains depend upon the type of soil, the depth of drainage required, and the topography of the area.

In all cases there will be a lateral subdrain system connecting with trunk lines. Four of the most commonly used patterns are: herringbone, natural, parallel, and gridiron systems.

Laying Subdrains

Depending upon the specific problem, subsurface drainage pipes may be plain or bell and spigot clay pipe laid with open joints, or standard ASTM perforated clay pipe laid with open or closed joints.

Bell and spigot pipe is ideal for subdrainage for several reasons. In the first place the short lengths and many open joints permit maximum infiltration, secondly, the bells keep the pipe in alignment after placement, and third, it is permanent.

Subdrains are frequently subjected to chemical attack by acids and alkalies from ground water. Such backfills as cinders are also highly corrosive. Therefore subdrain pipes must be completely rust, rot, and chemical proof.

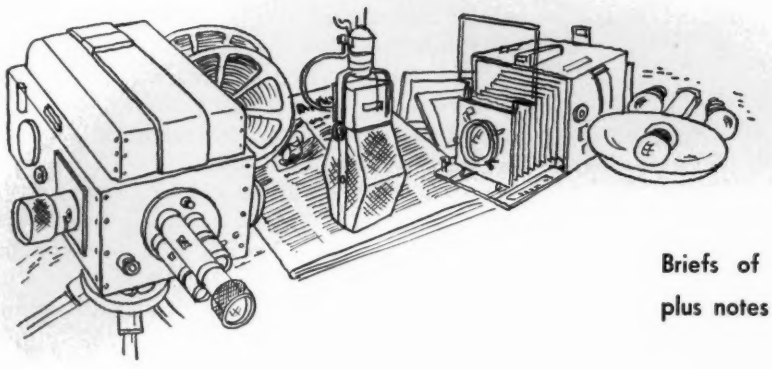
To permit maximum infiltration into the pipe, the backfill should be a coarse, porous material such as gravel, crushed rock, cinders, or coral. Depth of the porous backfill depends upon the problem at hand. Where the subdrain is to trap and carry away subsoil water only, it is not necessary in most cases to carry the porous backfill more than 6 in. above the top of the pipe. Excavated earth can be used for the remainder of the backfill, *provided that such material is above groundwater level.*

To prevent openings in the pipe line from clogging before silt and other loose materials are washed down and the drainage channels in the soil are established, it is good policy to cover the top of the joints with small squares of water proof building or roofing paper.

Sizes of Subdrains

Amount of subsurface runoff is approximately equal to the amount of precipitation that soaks into the ground. Whereas, maximum discharge from a storm surface-drainage system occurs shortly after a rainfall, maximum discharge from a subdrainage system generally occurs long after the passage of the storm. It takes time for the water to pass through the soil and to reach the pipe lines.

Quantity of subsurface runoff is expressed as a certain depth of water (in inches or fractions thereof) to be drained off within a period of 24 hr. Data found in chart give the required discharge capacity of drains to remove various depths of water in 24 hr. The curves designate the portion of the rainfall, which passes through the soil to the drainage pipe. For convenience, the curves have been prepared with coefficients ranging from 1/16 to 1 in. in 24 hr. Where more accurate data are unavailable, 3/8 in. may be considered normal for computations.



NEWS

Briefs of current interest to the consulting profession plus notes on new equipment in the field of engineering

Simplified Drafting Combats Skilled Manpower Shortage

Streamlined industrial drafting is being employed by General Electric Co. as a means of combating the skilled manpower shortage. More than 5000 draftsmen are being encouraged to strip the frills from their drawings, which has resulted in saving 20 to 30 per cent of the time normally required for preparation, as well as substantial savings in materials.

Simplification and elimination of non-essentials is being done without surrendering either clarity of presentation, or accuracy of dimension. Extra views, unnecessary elaboration, superfluous lines, repetition, and conventional representation instead of symbolism, are but a few examples of work that never should have been done.

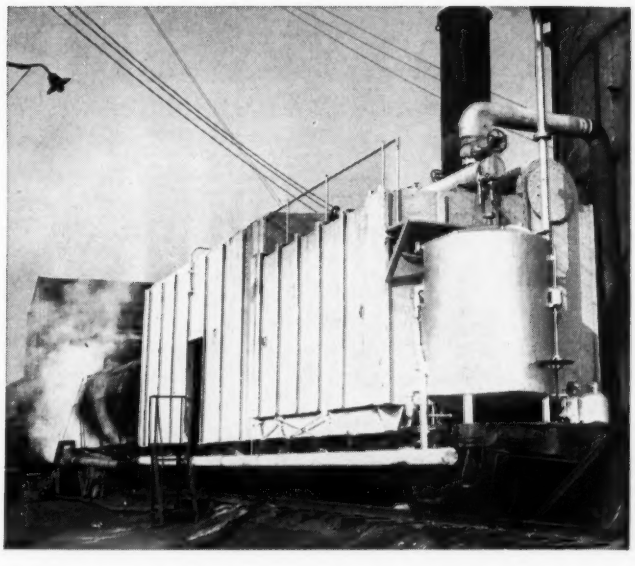
An actual example of time saved by simplification is shown in the photograph. In this case, a drawing requiring 4 sq ft of paper and two days to prepare, serves the purpose of the larger drawing, which required 57 sq ft of paper and eight days to prepare.

Another time-saving practice is the extension of free-hand drawing beyond its present narrow limits. Tests have proved that free-hand drawing, when used judiciously, is both practical and economical. With all factors made equal, actual drawing time is reduced between 20 and 30 per cent.

In addition to the savings of time and materials, simplification will make additional time available for the most important part of any draftsman's job—the real productive effort of creative thinking.

Boiler Plant Moves Over Rails To Meet Expanding Operations

Faced with the need for additional steam capacity at different locations, the engineering department of Publicker Industries, Inc. has designed and built a boiler plant on wheels. The boiler provides a capacity of 20,000 lb per hr of steam, and the complete unit is



mounted on a flat car supplied by the Pennsylvania Railroad. The railroad's engineers aided in designing the unit to meet specifications of the American Association of Railroads for moving over main line rails.

The boiler is a Babcock & Wilcox standard model with 250 psi maximum pressure. The plant also contains a feedwater heater, pumps, starting gas, a water

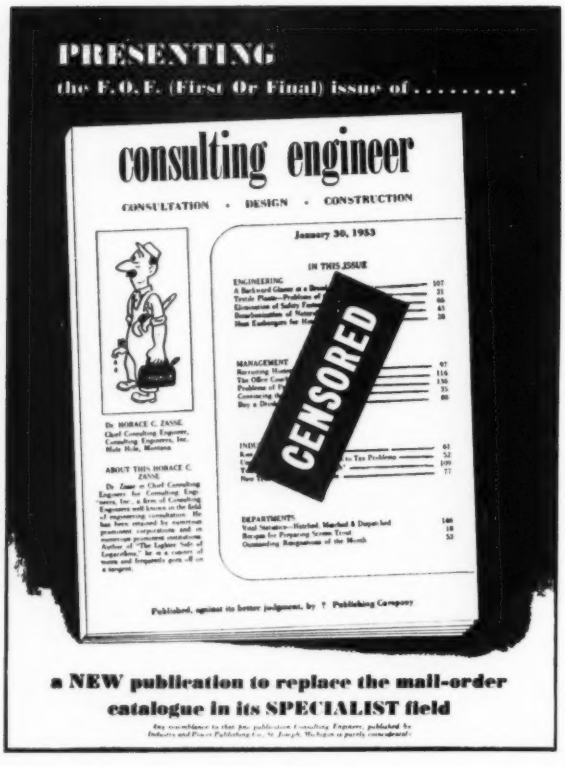
(Continued on page 56)

Boiler Plant on Rails

—*Starts on page 55*

treating unit, and outside clips for service connections. Only outside electrical, water, oil, and drain connections have to be changed when the boiler is moved. A 440 v electrical connection is used. Only one engineer is required to operate the plant.

At present the installation is being used to clean tanks, operate steam pumps, and supply heat.


PRESENTING
the F.O.F. (First Or Final) issue of.....
consulting engineer
CONSULTATION · DESIGN · CONSTRUCTION
January 30, 1953
IN THIS ISSUE
CENSORED
a NEW publication to replace the mail-order catalogue in its SPECIALIST field

F.O.F. Jamboree "Honors" Consulting Engineers

The F. O. F. Golf Association, a now famous group of fun-loving engineers, held a "Consulting Engineers Night" on January 30th, at the Hotel Astor in New York. At this Annual Jamboree, which is hardly a serious affair, approximately 1000 executives and engineers enjoyed a full meal and a floor show extravaganza seldom equaled in the staid, old Astor Ballroom. All members and guests were presented with a special publication burlesqueing CONSULTING ENGINEER, prepared with absolutely no help from CE's editorial staff. While readers might find the burlesque edition every bit as interesting as its model, postal regulation would forbid its even being carried to the door of a post office.

The special issue carried a symposium of representative opinions on the definition of a Consulting Engineer which, with just a little polite editing, is reprinted below:

By a Consulting Engineer—"A practical scientist whose extraordinary intellect, superb education, and rigorous ethical standards are freely offered for the benefit of humanity."

By an Architect—"The inevitable result of ruining a potential plumber by too much education."

By a Contractor—"An arrogant bum in a blue suit, who asks you a question, answers it for you, and then tells you that you are wrong."

By a Secretary—"A pompous old bloke who starts dictating specifications at ten minutes to five."

By a Plant Manager—"A would-be wise guy, too lazy to work and too yellow to steal."

By a Competitor—"A purple-bellied skunk, *to the fourth decimal place.*

By an Equipment Salesman—A purple-bellied skunk, *or equal.*"

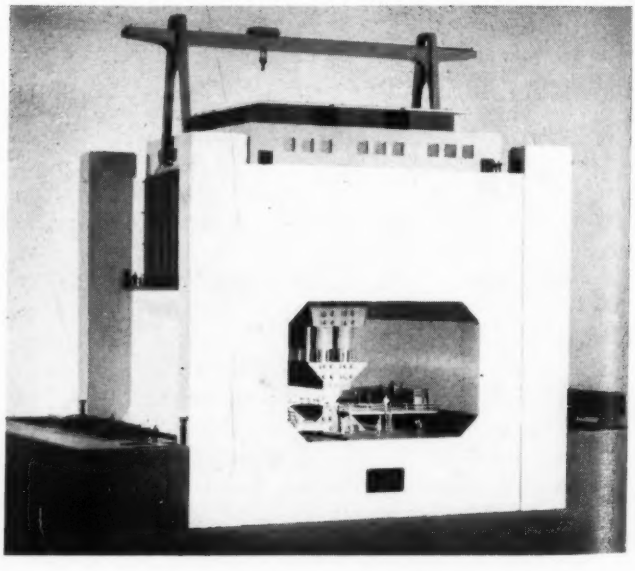
By a Purchaser—"A purple-bellied skunk, *net.*

Equipment Provides Automatic Power Factor Control

Capacitors, a standard means of correcting low power factor in industrial plants, are usually controlled manually to meet plant demands.

Although engineers responsible for cost of power are well acquainted with the use of capacitors, many of them are not aware that equipment is available to automatically cut capacitors in and out. This equipment holds the power factor at plus or minus two per cent from no load to full load, and meets the requirements of plants having wide load fluctuations.

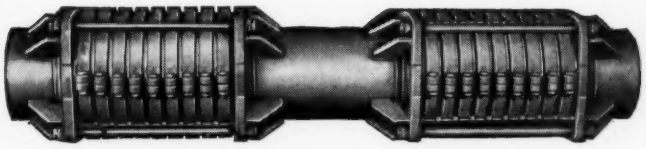
Franklin Engineering Corp., a consulting engineering firm, reports that it used this equipment in two plants last year; the Thomson Co., Thomson, Ga., and High Rock Mills, Inc., Philmont, N. Y.



Throatless Press Provides Full Access For Handling Large Irregular Pieces

Gigantic throatless presses with capacities of more than 75,000 tons are now possible because of a new concept in machine design. The presses will provide

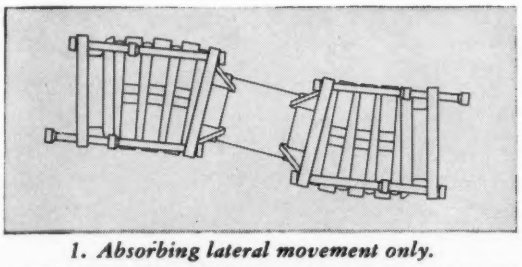
(Continued on page 58)



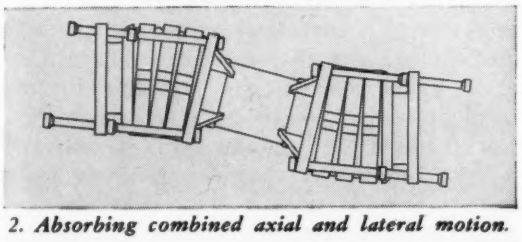
Universal Packless Joint

ADSCO *Joint*

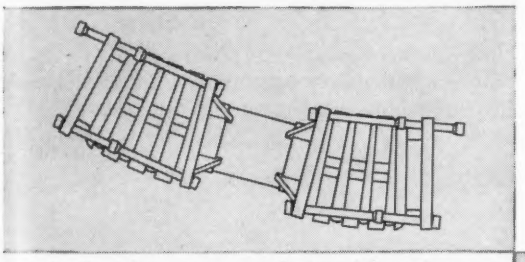
...THE UNIVERSAL FAVORITE



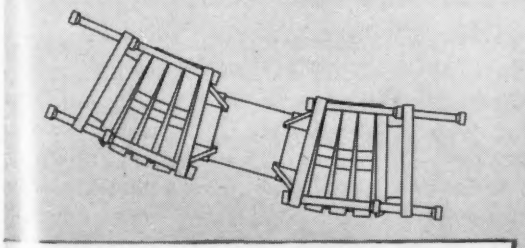
1. Absorbing lateral movement only.



2. Absorbing combined axial and lateral motion.



3. Angular rotation without axial motion.

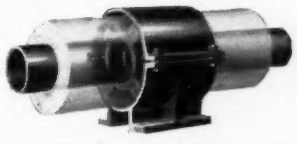


4. Combined angular and axial motion.

● When it comes to expansion joints, ADSCO is the universal favorite because ADSCO — and only ADSCO — makes a complete line of joints, both slip and packless.

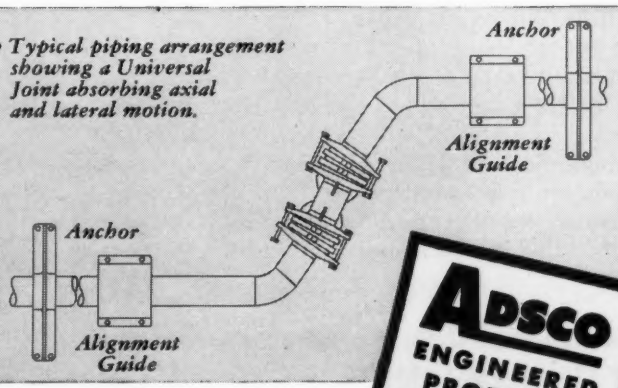
And if your problem is to absorb pipe line movement in all planes simultaneously, ADSCO Universal Packless Joints are the favorite . . . Often it is impossible or impractical to eliminate lateral motion or to isolate lateral from axial motion by anchors and guides. In these circumstances, the Universal Joint will reduce the number of anchors required and consequently reduce the amount of steel work necessary to support them. In Drawing 1 at the left, the Universal Joint is shown absorbing lateral movement only. By lengthening the intermediate pipe nipple the amount of lateral movement can be increased without increasing the number of corrugations. In Drawing 2, the same joint is absorbing combined axial and lateral motion. Drawing 3 illustrates the joint in angular rotation without axial motion. Drawing 4 shows combined angular and axial motion.

ADSCO can solve *any* of your pipe expansion problems. Call your ADSCO representative or write for Bulletin 35-51A.



● *For best results, use ADSCO Pipe Alignment Guides.*

● *Typical piping arrangement showing a Universal Joint absorbing axial and lateral motion.*



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NORTH TONAWANDA, NEW YORK

Since 1877

Throatless Press

—*Starts on page 56*

360 degree access for placing or removing dies and work requiring closed die forging, rubber pad forming, and die quenching operations. A new enterprise, the Throatless Press Co., has been organized jointly by The Austin Co. and The Hydraulic Press Mfg. Co. to pioneer this field.

To eliminate tie rods and tension members of conventional presses, a massive monolithic concrete structure will serve the three-fold purpose of supporting, suspending, and completely housing all press elements and operations. The mass provides counter-force required to resist the tremendous pressure developed in forming large members.

Concept of this throatless press originated with C. A. Van Dusen of the Van Dusen Engineering Co. He first considered installing the press elements in a cave and suspending the press head, cylinders, and slide from the roof.

Because of the nature of the problems involved, preliminary studies of the design as related to a 75,000 ton press have been made jointly by Austin and HPM. Their studies indicate that presses of 200,000 and even 300,000 tons now appear to be both practical to build and economically feasible.

Actual dimensions of the concrete mass have not been announced, pending completion of final studies. A model has been constructed, however, and it indicates an approximate over-all height of 180 ft would be required for a 75,000 ton press. Thirty feet of this would be below the ground-level press room. The frame walls would be 80 ft apart, and there would be a clear height of at least 50 ft below the concrete mass. An initial length of 120 ft is indicated. Because of unitized design, the length could be increased, dimensions of the bed could be extended, press sections could be added to increase tonnage or pressing-area capacity, or a line of smaller presses could be installed within a single frame.

According to preliminary estimates, installed cost of a 75,000 ton throatless press, including the entire enclosure and all of its auxiliary equipment, would be substantially less than for a conventional press of comparable size with required auxiliaries.

The idea of the throatless press is not limited to huge-tonnage machines. It may be practical to build machines down to 5000 ton capacity for use on forging or forming operations. A line of such presses could be installed in one frame.

Dravo Is Appointed Representative For New Oxidizing Catalyst

Oxy-Catalyst, Inc. has appointed Dravo Corp. as sales and engineering representative for Oxycat, a new oxidizing catalyst developed by Eugene J. Houdry, pioneer in the catalytic cracking of petroleum.

Oxycat first gained recognition last May when the Enamelstrip Corp. of Allentown, Pa., installed a bed of the new catalytic units to burn off noxious solvent

Workman is shown completing a bed of oxidizing catalysts in exhaust stack at Enamelstrip

fumes. The Oxycats generated enough heat energy to cut plant fuel bills by 90 per cent.

Each unit, measuring 5½ in. long, 3-1/8 in. high, and 3 in. wide, is made up of two porcelain end plates and, between them, a porcelain spacer bar and 73 porcelain rods which are coated with a .003 in. film of the catalytic agent, consisting of catalytic alumina and platinum alloy. The units are stacked side by side and one on top of the other in exhaust stacks of furnaces, ovens, or power plants, and the waste gases flow across them. Combustion of the gases occurs at the surface of the rods. The heat released can in most cases be channeled for useful purposes.

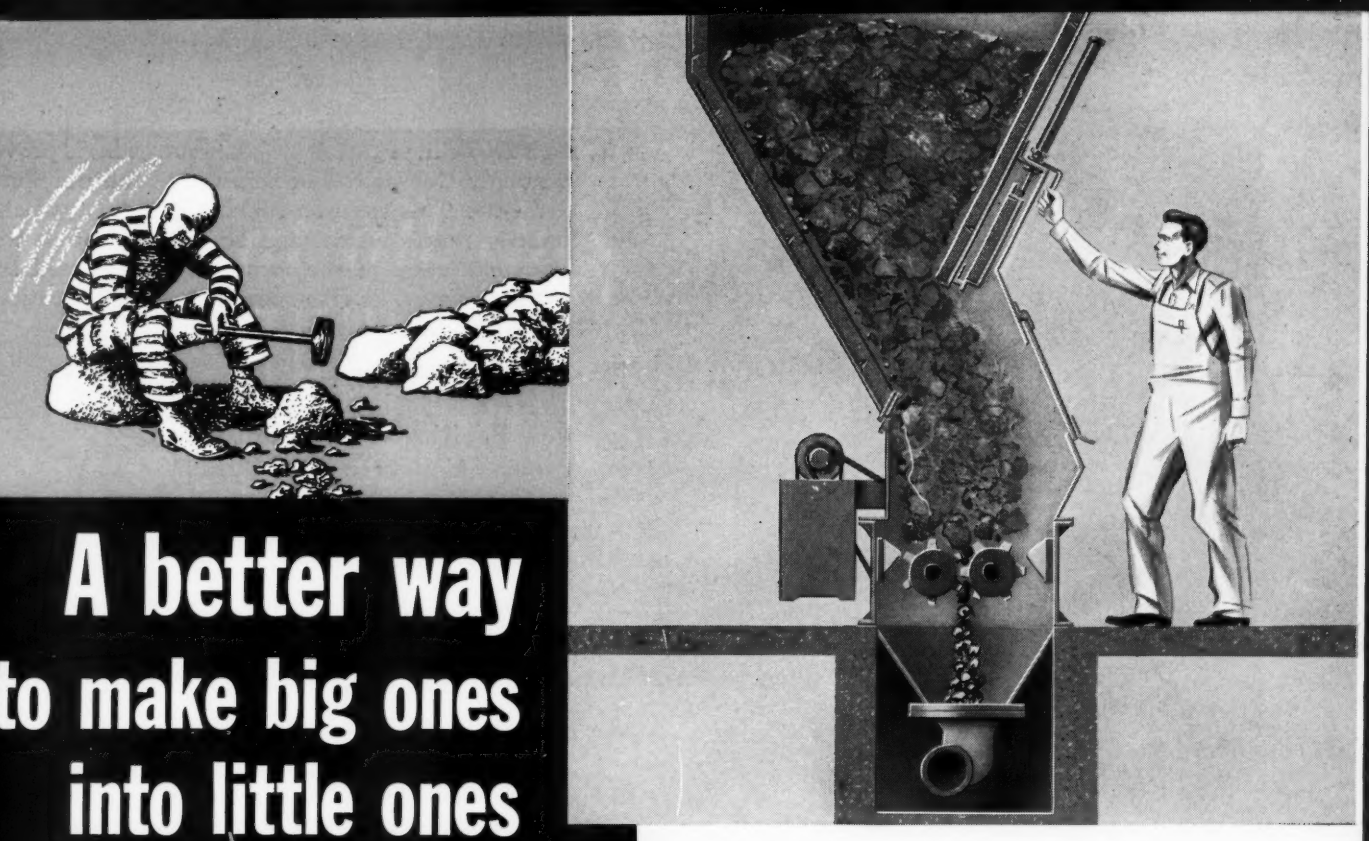
Dravo, through its Machinery Div., will be responsible for sales, application engineering, installation, and service in Michigan, Indiana, Ohio, Kentucky, Pennsylvania, West Virginia, Maryland, Virginia, Delaware, and New Jersey.

New Type of Reactor Produces Electricity From Nuclear Energy

Electricity from nuclear energy has been produced in a new type of reactor at the Oak Ridge National Laboratory, according to Union Carbide and Carbon Corp., which operates the laboratory for the Atomic Energy Commission. The reactor, known as a homogeneous liquid-fuel type, uses a homogeneous solution to serve as fuel, moderator, and coolant. Heat generated by nuclear reaction of uranium in the solution is removed by pumping hot radioactive liquid through a heat exchanger, which produces steam to drive a turbine-generator.

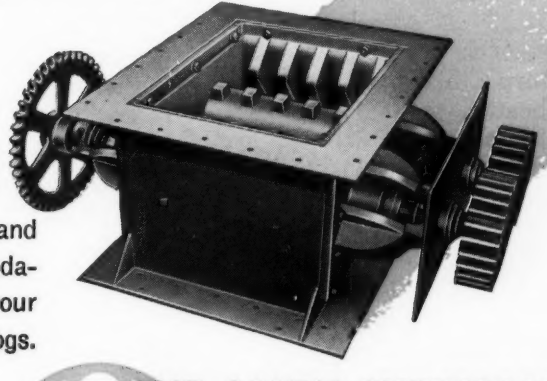
In the experiment, the system was brought up to its full heat output capacity, equivalent to 1000 kw. Steam was then used to operate a turbine-generator and approximately 150 kw of electrical energy was actually produced.

(Continued on page 60)



A better way to make big ones into little ones

We've learned a lot about making clinker grinders in the past quarter century, and we believe this new model is the best around. Users report that it is not only extremely rugged, but also saves substantial amounts of power. All main bearings are protected by pressurized lantern rings for smooth performance and long life. Designed to grind down to 3-inch spheres.



This new A-S-H Clinker Grinder is just another example of how our engineers "git there fustest with the mostest" in ash and dust handling equipment. Their recommendations will be of vital assistance to you on your next project. Write for our latest catalogs.

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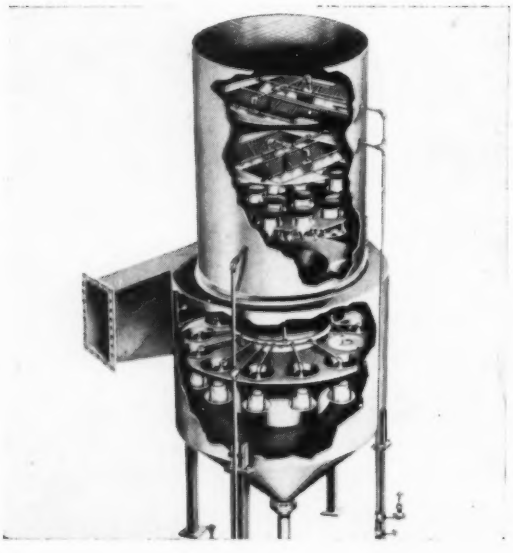
HYDROJET *(hydraulic)* **HYDROVAC** *(pneumatic)*

materials handling systems

Electricity from New Type Reactor

—*Starts on page 58*

The unit at Oak Ridge, which produces both fissionable material and electric power, is the first to operate at a temperature high enough to produce steam to run a standard industrial turbine. It must be emphasized, however, that the unit was not designed to operate economically. Many problems still remain to be solved. Experimental work will continue with higher electrical output to acquire information regarding the feasibility of this type equipment for full-scale commercial operation.



Multiple-Action Scrubber Provides Efficient Control of Stack Dust

Six different principles of dust precipitation are combined in a recently developed system for controlling stack dust. According to the manufacturer, Johnson-March Corp., this provides an unusually wide range of applications and design flexibility. The system is said to be capable of removing extremely large volumes of dust. Operating efficiency, even at unusually high dust loadings such as found in asphalt plants, is said to assure freedom from air pollution.

Suggested applications for the unit, known as the type V multiple-action scrubber, include control of dust from rotary dryers, cyclones, kilns, roasters, mixers, and pulverizer exhausts, as well as from stacks of asphalt plants, chemical plants, and similar industrial operations.

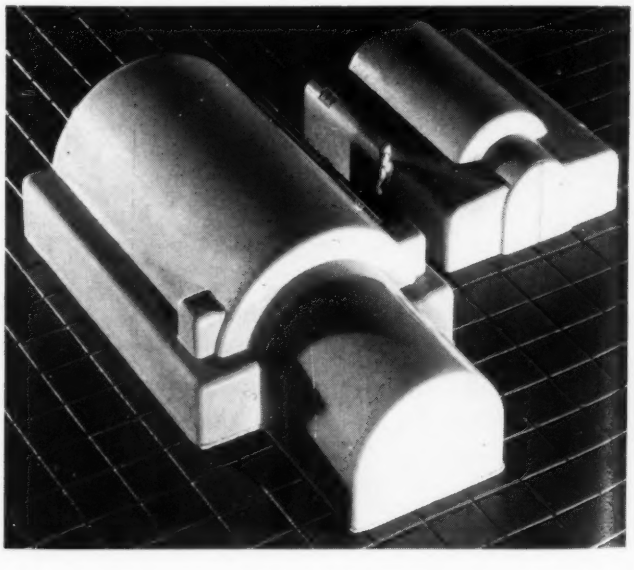
Much less water is required than in other types of scrubbers, and average draft loss is about 2 in. of water. Connections are made to existing duct work without complicated piping. Units are built in capacities from 1500 to 48,000 cfm.

Dust is reduced to a watery sludge which can be discharged into a tank or pond for removal of the solids. A recirculation system can be used where water supply is a problem. For best results, approximately 2 gpm of water at 40 to 50 psi are required for each 1000 cfm of gas. A proportioning unit is provided to supply Compound M solution to the precipitator elements. This solution rapidly wets dust which ordinarily repels water, and is said to provide maximum efficiency in the removal of entrained solids from the gases. It also speeds water clarification by causing solids to settle.

New Facilities Will Manufacture Precast Concrete Wall Panels

Plans for a $100,000 expansion of existing facilities at Baltimore, Md., have been drawn up by The Marietta Concrete Corp. The new plant will be devoted to the manufacture of precast concrete wall panels. Capacity is expected to be 2000 sq ft of finished panels a day.

Precast concrete panels, developed for quick, low cost curtain-wall construction, made their initial appearance in the industrial building field more than a year ago. At that time, over 600,000 sq ft of finished wall panels were supplied for the multi-million dollar, Marietta, Ohio, plant of the Electro-Metallurgical Div. of Union Carbide & Carbon Corp. The panels are usually 8 ft x 10 ft x 5 in., and consist of two layers of high strength concrete separated by rigid insulation. They are cast with metal inserts and are bolted directly to the building framework. By using this type of construction, a crew of nine men can erect 3500 sq ft of finished wall a day, at a cost of approximately $2.25 to $2.50 per sq ft.

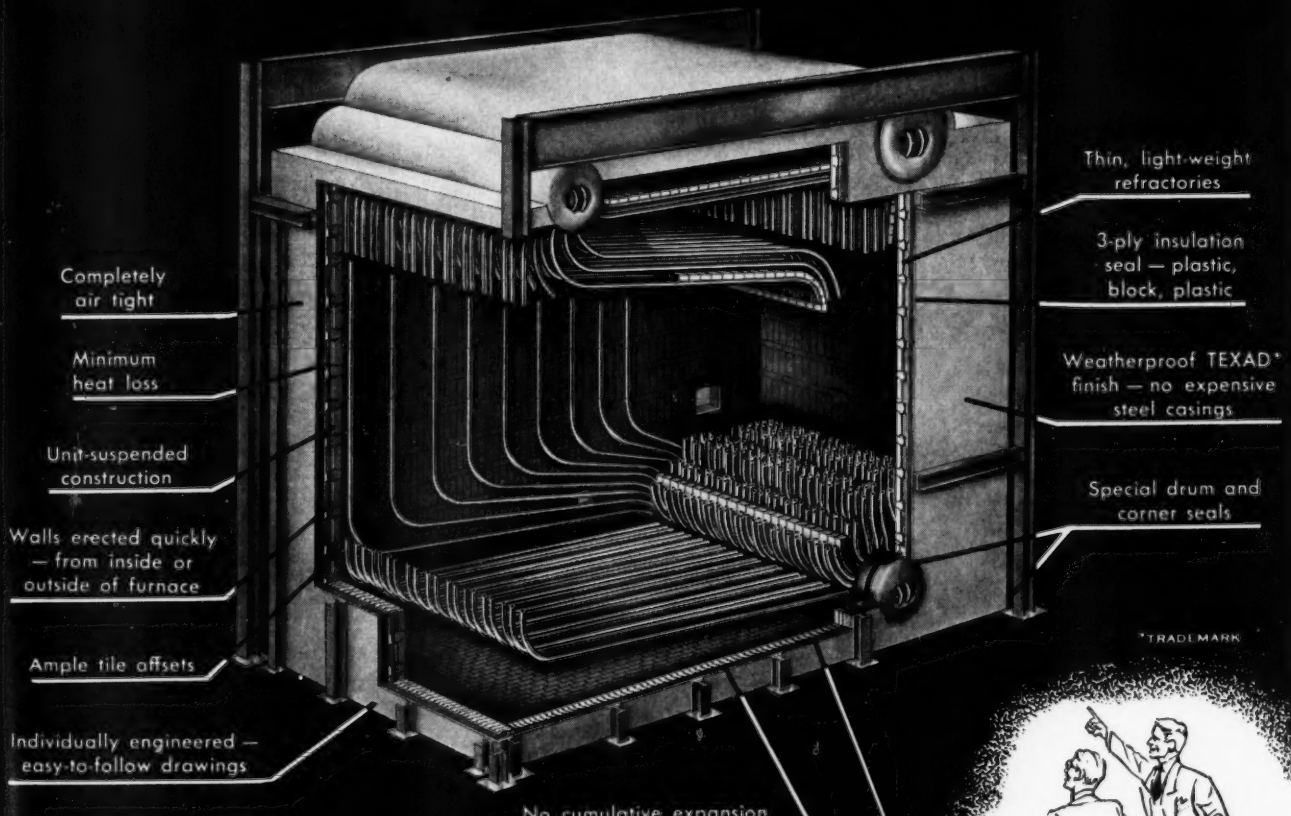


Design of Supercharged Generator Provides Drastic Size Reduction

Allis-Chalmers Manufacturing Co. reports that the first completely supercharged steam turbine generator is now under construction. The new design permits important size reduction, as shown in the illustration in which a scale model is placed

(Continued on page 62)

Look at all the advantages of B-L THIN WALL *construction for Industrial Furnaces*


Completely air tight
Minimum heat loss
Unit-suspended construction
Walls erected quickly — from inside or outside of furnace
Ample tile offsets
Individually engineered — easy-to-follow drawings
No cumulative expansion
No cumulative loading
Thin, light-weight refractories
3-ply insulation seal — plastic, block, plastic
Weatherproof TEXAD* finish — no expensive steel casings
Special drum and corner seals
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Supercharged Generator

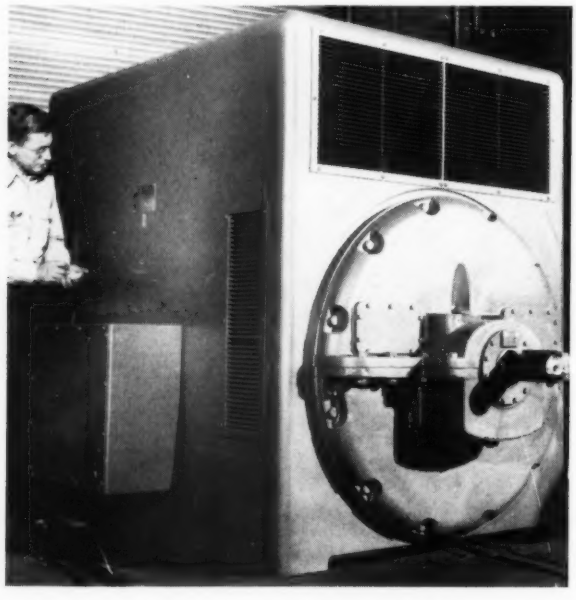
—Starts on page 60

alongside a model of a standard hydrogen cooled machine of the same rating.

This latest step in size reduction of steam turbine generators follows the development of supercharged cooling in the rotor, first used in a 60,000 kw generator installed in the Edgewater Station of Wisconsin Power and Light Co., Sheboygan, in 1951.

In this newest development, cooled hydrogen is forced through the conductors of both the stator and rotor. Heat removing ability is so effective that both generator length and diameter are cut to the remarkable ratio shown by the model. Exciter size has also been reduced by a new excitation system.

The first completely supercharged machine is being built for development and test purposes. It will have a nominal rating of 40,000 kw and a 60,000 kw rating at increased hydrogen pressure.



Boiler Feed Pump Motor Features Improved Ventilation System

Cubical design, a special high-speed rotor, quieter operation, and an improved ventilation system are important features listed by General Electric Company's Medium Induction Motor Dept. for a new boiler feed pump motor designed for use in power generating stations.

Heated air from the motor discharges away from workers and other nearby motors. This contributes to employee comfort and permits adjacent units to be mounted closer together without harmful recirculation of hot air. The air is drawn in from the motor's sides and expelled at a higher level, from the shaft end, over the couplings and boiler feed pump.

Over-all width has been reduced by cubical design, so that motors may be mounted closer together. The high-speed rotor, designed to operate at 3600 rpm, is said to receive a special finish to reduce turbulence and noise. Quieter operation is further achieved by a large air discharge chamber and the baffling effect of louvered inlets and outlets. Units are available in ratings of 1000 hp and larger.

Plastic Coating for Insulated Lines Provides Protection and Identification

For use as both protection and color identification on insulated refrigerant, cold water, steam, and other lines and insulated equipment, Armstrong Cork Co. has developed a plastic coating that can be either brushed or sprayed on. The new finish, known as Insulcolor, will withstand temperatures to 160 F without cracking, shrinking, or crazing. It may be used over heat insulations, cork pipe covering and lagging, and also as a finish over cork-insulated air conditioning ducts. It can be applied over standard asphaltic finishes without danger of bleeding through. In addition, it can be used as an adhesive for pasting down canvas, asbestos, and other lagging cloths, thus eliminating the need for sewing.

High water resisting properties make it suitable for both inside and outside applications. A tough finish provides resistance to bumping and abrasion. When dry, it is classified as fire-retardant. The coating is available in white, light and dark green, light and dark blue, yellow and buff.

Cast Iron That Twists and Bends To Be Exhibited at Metal Show

Cast iron that will bounce on impact instead of breaking, and will twist and bend, is to be one of the features displayed by The International Nickel Co., Inc. at the Western Metals Exposition in Los Angeles, March 23-27.

Known as Ductile Iron, it was first made available commercially in 1949, when the year's total production was 3500 tons. This jumped to about 100,000 tons

in 1952. Basically, it is gray iron to which a small amount of magnesium and nickel has been added. The new metal, in effect, is a new engineering material that bridges the gap between iron and steel.

In addition to being ductile, the material is reported to be wear and heat resistant. Company research engineers have listed over 500 established and 200 experimental applications. Uses are found in almost every branch of industry from petroleum production and refining to airplane engine building, and from pump construction to gear production.

New Plant Will Manufacture Equipment for Atomic Reactors

Atomic power, as a commercial business, is a step nearer reality with the announcement by Westinghouse Electric Corp. of its plans for a new, multimillion dollar plant to produce atomic equipment. The new facility, believed to be the first major private enterprise of its kind, will be located in Harmar Township near Pittsburgh. It will be operated by the Atomic Equipment Dept., a newly formed department in the Atomic Power Div.

Products of the new plant will be special items which could not logically be produced by existing company operations. It is widely known that the company's work on the atomic submarine reactor project has involved development of many unusual types of equipment, including "canned" motors to drive pumps in hermetically sealed systems, and other special purpose items.

In discussing the project, G. A. Price, President of Westinghouse, stated, "This investment in the commercial future of atomic power is an expression of our belief that private enterprise generally will become an increasingly important factor in the future development and application of nuclear energy in its non-military aspects."

Unusual Construction Practices Speed Completion of Texas Refinery

Two unusual practices used by Catalytic Construction Co. in constructing new facilities for the El Paso refinery of Standard Oil Co. of Texas, are reported to have reduced cost and time. The contract included design and construction of an 11,500 bpd synthetic crude unit, an 11,500 bpd Houdriflow catalytic cracking unit, a 7555 bpd vacuum flash unit, a gas recovery unit, and an alkylation plant.

Orthodox construction practice for an installation of this type would have called for erection of a guy derrick to set top pieces of equipment on the cracking unit, which reached a height of 360 ft. Foundation costs, erection charges, and rental or depreciation of a derrick pedestal for such service frequently costs $50,000 to $65,000.

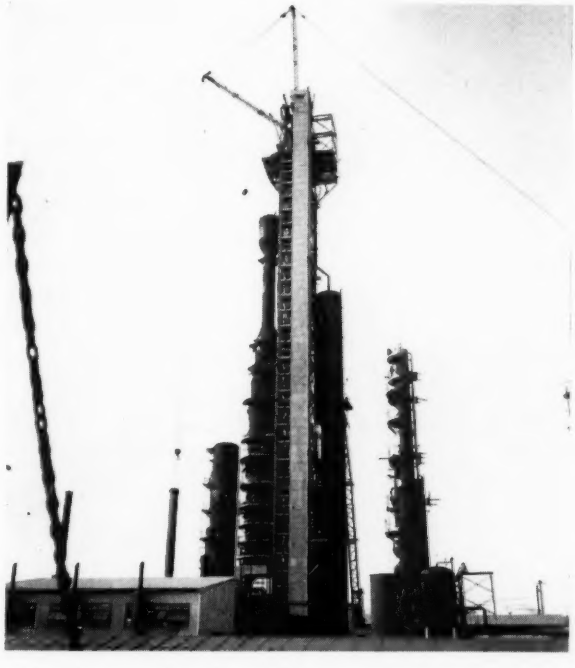
Extremely limited working area made the usual guy derrick impractical. Use of the Houdriflow stairwell and elevator shaft offered an alternate possibility, with the added advantage that none of the erection cost would have to be written off as cost of construction equipment.

Guying the structure for adequate support of the derrick, with its 100 ft boom and 25 ton capacity, was considered. If guys were used, however, each piece of equipment would have to be raised to the top of the structure and rotated 90 degrees before being lowered into place. On the other hand, if the structure were reinforced, guys could be eliminated. Additional cost of reinforcing was less than $1000.

Erection of the structure was accomplished with a basket pole. As the steel was raised, the derrick mast and boom were assembled within the steel framework and, when the structure was topped off, the derrick was ready to be set and raised immediately. After the derrick had served its purpose, only a few days were required for disassembly.

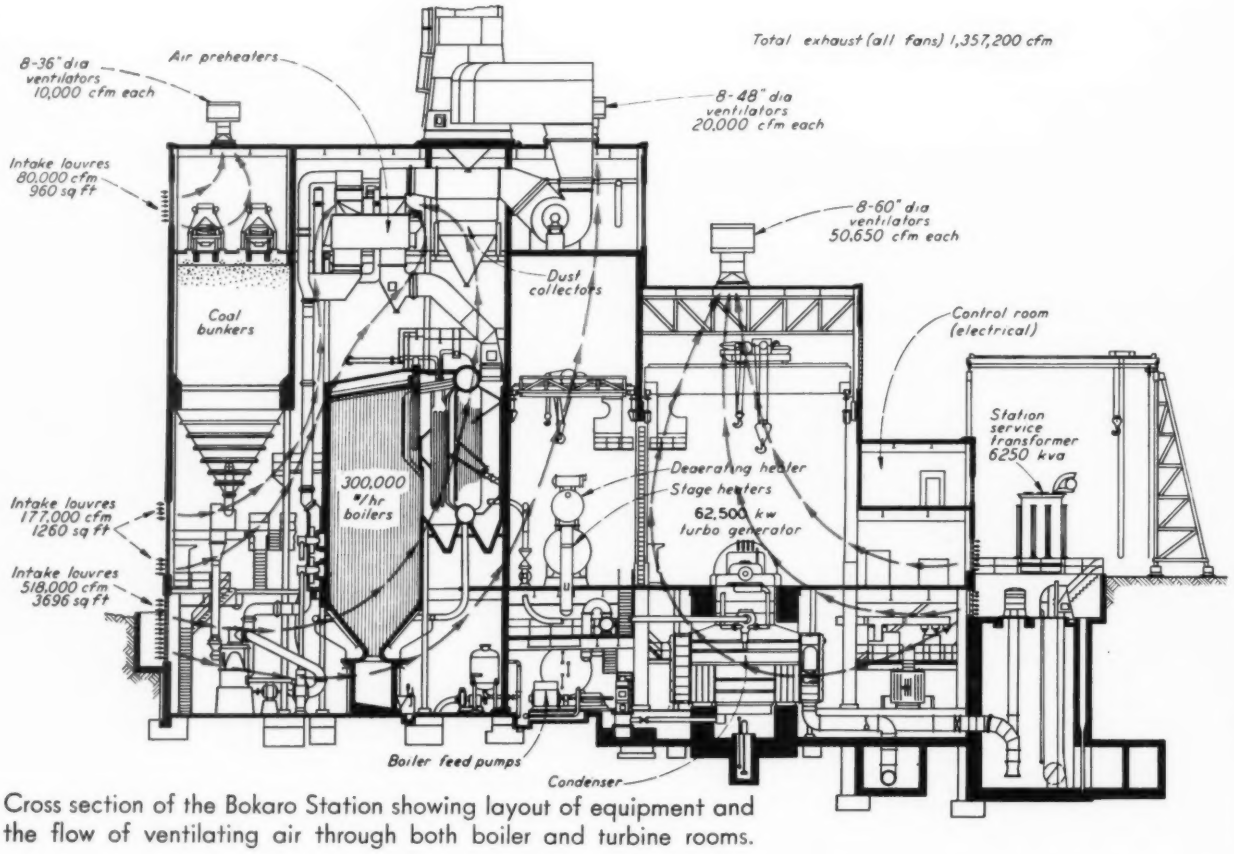
The second unusual practice also was a result of limited construction area and lack of accessible storage space. In this case, construction and material-delivery schedules were timed to permit installation of equipment upon arrival. This offered the added advantage of eliminating double handling.

To accomplish this, accurate delivery dates had to be established on a schedule to permit proper sequence of field work. Weekly construction plans were laid with delivery schedules as the determining factor. This provided only a minimum of flexibility, and strict adherence was necessary to avoid loss of man hours. In actual practice, only one delay in a major equipment item was encountered, and in this case it was possible to change construction schedules.



Nearly completed catalytic cracking unit showing the guy derrick, mounted on its top, in action

Success of such unusual practices is said to have been due largely to maximum coordination of the various functions, made possible by the contract which provided for all engineering, design, purchasing, inspection, expediting, and construction.


Total exhaust (all fans) 1,357,200 cfm
8-36" dia ventilators 10,000 cfm each
Air preheaters
8-48" dia ventilators 20,000 cfm each
Intake louvres 80,000 cfm 960 sq ft
8-60" dia ventilators 50,650 cfm each
Dust collectors
Coal bunkers
Control room (electrical)
Station service transformer 6250 kva
300,000 #/hr boilers
Deaerating heater
Stage heaters
62,500 kw turbo generator
Intake louvres 177,000 cfm 1260 sq ft
Intake louvres 518,000 cfm 3696 sq ft
Boiler feed pumps
Condenser

Cross section of the Bokaro Station showing layout of equipment and the flow of ventilating air through both boiler and turbine rooms.

John F. Helman and Milton Tucker
Building Service Dept. Specifications Dept.
The Kuljian Corporation
Engineers - Constructors

Ventilating India's Bokaro Steam Station

Some time this year the people of India have hopes of witnessing a new era—an era of lessening floods, famine, unemployment, and other misfortunes that the country has endured for centuries.

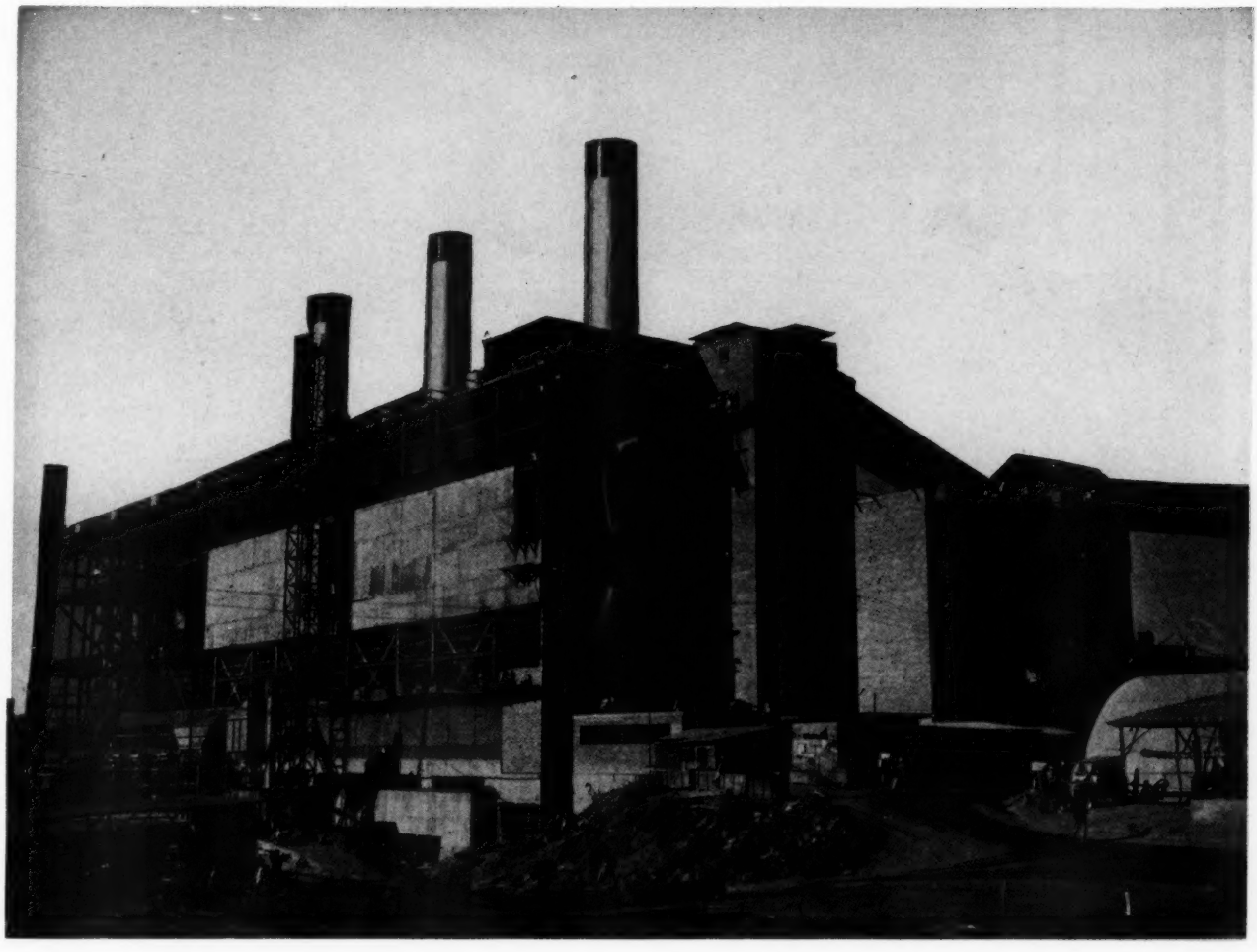
This new era opened on February 21, as Prime Minister Nehru threw a switch at the dedication of the first unit of the vast development program of the Damodar Valley Corp., the $140,000,000 project conceived by Prime Minister Nehru's Government in 1948. This great Damodar Valley, lying north and west of Calcutta, is not only a potential bread basket for hungry India, but its cheap coal deposits and unharnessed waterheads promise to supply ample electrical energy for India's industries.

One of the first units to be completed in this program is the 240,000 kw Bokaro Thermal-Electric Power Station, the largest steam power plant in the Far East and the first high pressure plant in that part of the world.

The total cost of the Bokaro plant will be $35,000,000. It was designed and is being constructed by The Kuljian Corp., of Philadelphia, who have built large utility plants around the world.

International General Electric Co. supplied three, 62,500 kw, steam turbine-generator units, built at Schenectady. The units operate at 3000 rpm and provide 50 cycle current at 13,800 v. Combustion Engineering-Superheater, Inc., is providing six boilers, each with a capacity of 300,000 lbs per hr.

The other units in the Damodar Valley will be



Bokaro Station, showing the boiler room exterior. Note louvers at top and bottom of walls and ventilators on roof.

hydroelectric stations designed for the fourfold purpose of (1) eliminating disastrous floods in a large area above Calcutta, (2) controlling land erosion, (3) providing cheap power during the heavy rains of the monsoon season, and (4) storing up water for use in irrigation during the dry season.

When the dams are completed, hydroelectric plants will combine with the Bokaro steam plant to quadruple the Damodar Valley's power supply. The Bokaro plant is designed to operate at peak load during the worst of the drought periods and maintain a steady supply of electrical power for surrounding industry.

The Bokaro Power Station will utilize coal from strip mines so close that a short conveyor will haul the cheap fuel directly from mine to boiler.

The plant is in a sub-tropical region subject to monsoons every summer. There are temperatures as high as 115 F during the summer month of May. It cools down to around 96 F during the monsoon season, with practically 100 per cent relative humidity. During the dry months, that is November to February, the temperatures are moderate. In this land of monsoons, high humidity, and high temperature, comfortable working conditions inside a power plant are highly desirable, and call for skilled engineering work and careful design.

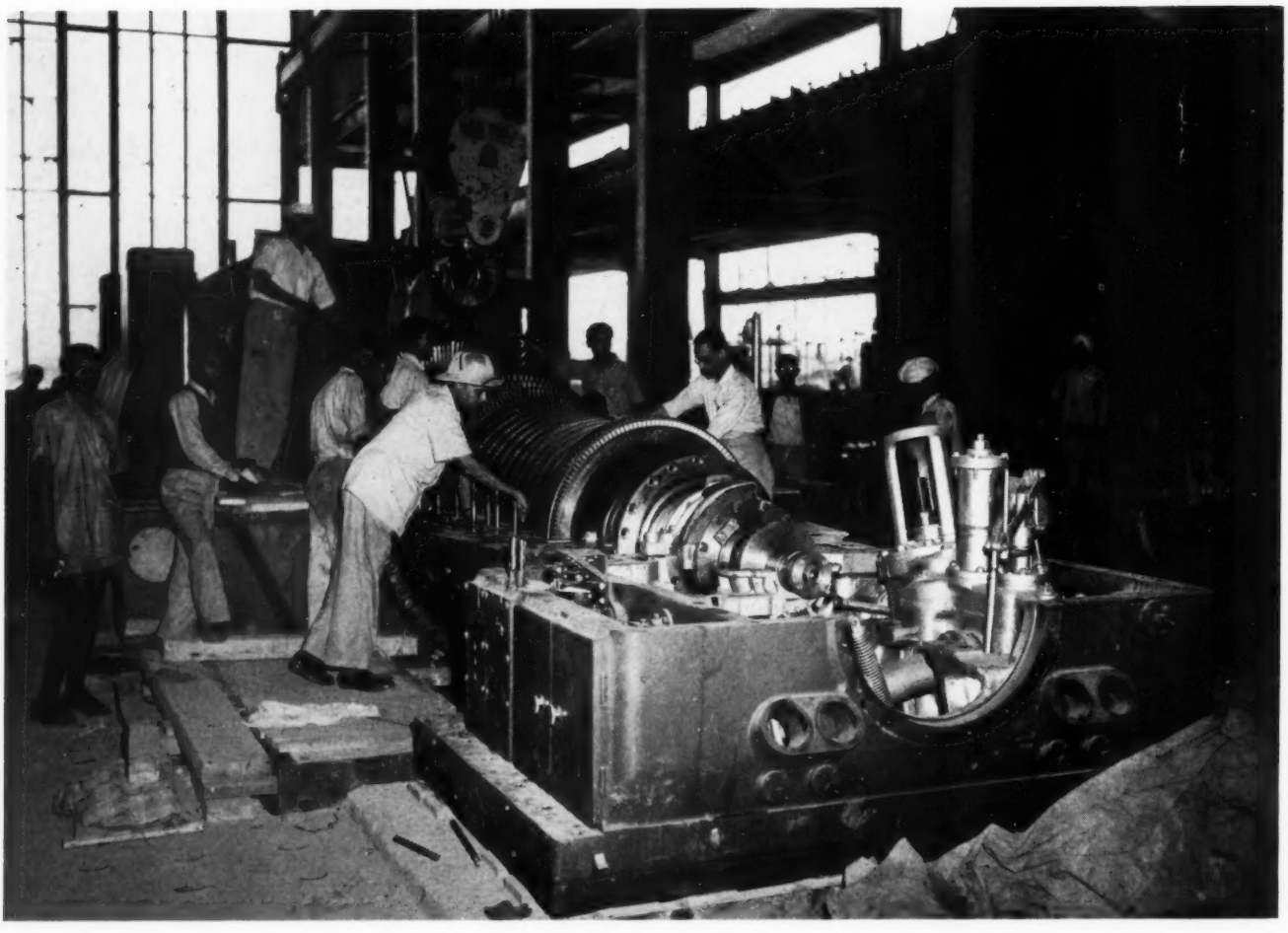
The boiler room, turbo-generator room, and switchgear room at Bokaro have been thoroughly and completely ventilated. The electrical control room, reception room, and office areas have been provided with refrigerated air.

In the boiler room the design figures were based on one air change every 4.6 min. There is one air change every 4.9 min. in the turbogenerator room area.

While the power generating equipment now installed is only 75 per cent of planned ultimate capacity of this station, ventilation figures presented here are based on 100 per cent capacity.

The ventilating system in the Bokaro power plant has conditions peculiar to itself. Instead of taking cooler air from the outside and preheating it, hot air already in the boiler house is fed to the preheaters through forced air fans, and this air is used for combustion in the boilers. This also prevents the stratification of hot air and helps to ventilate the boiler house. The large capacity forced draft fans permit an economical use of reduced pressure inside the building, and keep the power and equipment requirements down to a minimum.

The eight forced draft fans supplying the boiler



Rotor of the No. 3 G.E. turbine going into place. The Indian engineers were trained by G.E. and the Kuljian Corp.

will handle a total of 712,000 cfm, and an additional 160,000 cfm is necessary to satisfy the 4.6 min. area air change. This additional requirement was handled by eight power roof ventilators, each pulling approximately 20,000 cfm. They are located on the boiler house roof at regular intervals. This combination of forced draft fans and power roof ventilators will move a total of 872,000 cfm. Provisions are made to introduce this amount of air into the boiler house through intake louvers.

The forced draft fans and roof ventilators are located near or at the roof, so it was decided to locate fresh air intake louvers at the basement operating floor and scale platform levels thereby obtaining maximum air travel and distribution. The air around the plant is free of fine dusts; and since the largest air intakes are situated at the basement level, and the air takes a few sharp turns before it enters into the power house proper, a reasonably clean air can be assured without filters and scrubbing equipment.

In the basement level, fresh air intake louvers in the east wall total 3696 sq ft gross area and are capable of handling 518,000 cfm at 140 ft per min. velocity. Since basement level is below grade, it was necessary to provide a concrete vent well of

VENTILATION DESIGN DATA

Bokaro Steam Station, Damodar Valley, India

	Boiler room area	*Coal conveyer room area*	*Turbo-generator room area*	*Totals*
Cubage	3,970,000 cu ft	205,000 cu ft	1,998,000 cu ft	6,173,000 cu ft
Cfm	872,000	80,000	405,200	1,357,200
Air change	4.6 min.	2.7 min.	4.9 min.	4.6 min.

sufficient depth to give free air access to louvers. Vent wells were provided with adequate weather protection and drainage facilities.

Grating of sufficient gross area to permit air passage at approximately 60 ft per min. velocity was installed in the operating floor adjacent to the boiler.

In the east wall at the operating floor level, fresh air intake louvers are spaced intermittently between instrument panels. These louvers provide 1260 sq ft gross area, handling 177,000 cfm at 140 ft per min. velocity. This arrangement provides ample ventilation from the operating floor to the scale platform. At the scale platform level, there have been installed fresh air intake louvers of the same size, spacing, and architectural arrangement as those at the operating floor level. These tiers of louvers have the same total capacity of all the forced draft fans and gravity roof ventilators in the boiler area, at a very low intake velocity.

The fan room floor is equipped with grating of sufficient area to permit air passage at a velocity of 93 ft per min.

At the conveyor floor level above the coal bunkers, 960 sq ft gross area of louvers have been installed and the dust from this area is exhausted through eight power ventilators regularly spaced on the roof over the bunkers. The bunkers are completely sealed off from the rest of the building, necessitating an independent ventilating system.

While there is no wall between boiler room and turbo-generator room, the ventilating calculations and design of these areas were made as though these were distinctly separate portions of the station.

In the turbo-generator room a total air volume of 405,200 cfm is exhausted through eight power roof ventilators spaced to give maximum air distribution. Fresh air intake louvers are provided in the west wall at the basement and operating floor levels.

At the basement level, fresh air intake louvers of approximately 1820 sq ft gross area are capable of handling 329,200 cfm at a velocity of 180 ft per min. The basement level is also below grade at the west wall, and it was again necessary to provide a concrete vent wall to give air access to the louver area located below grade. Since the circulating water pumps, station service pumps, and electrical transformers are also located near the west wall, this vent well is not continuous but is made up of a series of wells located between the equipment. Grating in the operating floor adjacent to the turbo-generators permits air flow at an estimated velocity of 208 ft per min.

At the operating floor level in the west wall of the switchgear area, fresh air intake louvers have been installed intermittently to provide ventilation for this area. These louvers are of 420 sq ft gross area, capable of handling 76,000 cfm at a velocity of 180 ft per min.

The louvers provided in the west wall are capable of handling a total of 405,200 cfm, the amount exhausted by this area's power roof ventilators. All louvers are of a manual operation type, fully open to fully closed, and are furnished with insect and bird screens.

The office area and electrical control room are air conditioned with cooled air by the use of two, standard, packaged 10 ton units. One unit is located adjacent to the electrical control room, with supply ducts concealed above the suspended plastic panel ceiling. Air passes into the control room through directional outlets flush with this ceiling. The other 10 ton unit is located in a separate equipment room above the floor level of the reception room, assistants' office, and chief engineer's office, and it supplies these areas with cooled air through exposed ceiling ducts and circular outlets.

Over-All Project

The ventilating system is only one of the interesting features of the entire Bokaro project, which involves three parts: the steam power station itself; the Konar dam, twelve miles from the plant, which furnishes cooling water; and 477 miles of transmission lines and substations. The coal handling equipment might also be considered an essential part of the project, for it is an aerial conveyor direct from the near-by Bermo strip coal fields, and it supplies coal at the rate of 700,000 tons per year.

The Damodar Valley project centers in one of the most highly industrialized regions of India. The region's hills contain 85 per cent of the world's best mica, 75 per cent of India's coal deposits, most of its iron ore, and large deposits of manganese, copper, limestone, bauxite, asbestos, and chrome.

Jamshedpur, India's "Pittsburgh," is expected to take substantial amounts of power from the new plant. Transmission lines will also supply Calcutta, nearly 200 miles away.

The steam plant is expected to carry the base load 37 weeks of the year, and the hydro plants will take over the bulk of the load during the 15 weeks of Monsoon weather.

Kuljian engineers are now operating the plant and will continue to operate it for a one year period. After this, eleven Indian engineers, trained in this country by the Kuljian Corp. and General Electric, will take over supervision of operations.

The Indian Government, the World Bank, and both American and Indian engineers shared in the development. The World Bank loaned $38 million to India for the project. Prime Minister Nehru considers this power plant the first unit in his ambitious plan for the betterment of India. In dedicating the plant, he paid a glowing tribute to American engineering skill and efficiency.

The Bokaro Power Plant is expected to open a new and brighter era in the economy and well-being of the people of India.

Covered fire area at Moyer Gulch, Wyo. Diversion ditch shown in foreground. Nearly 34,000 cubic yards of incombustible material was used over the fire, which was started in 1885 by a horse thief.

Fighting Underground Fires

HENRY S. GALUS

The most fabulous horse thief who ever outgalloped a hard-pressing posse hid out one night about eight miles south of Gillette, Wyoming. Inhabitants of the area have since learned to call him the "multi-million-dollar varmint" because he started a fire that cold, damp night in a Moyer Gulch mineshaft.

It burned for 65 years in a cancerous path through a coal-rich bed. Though no one estimates the tonnage that had been destroyed before the U. S. Bureau of Mines new branch of underground fire fighters snuffed out the smoulder last May, the coal saved amounts to 145,000 tons per acre—or a total of 14½ million tons, worth about $45 million.

Few were happier in 1949, than Bureau Director James Boyd when, upon the insistence of his staff experts and geological researchers, a barely noticeable "outcrop fire-control clause" was written into the Interior Department appropriation act. "At last," said Mr. Boyd, "we can warm up our 'fire engines' and start the job that should have been done long ago."

The job, as it stands in semi-completion today, has already spared from certain ruin an estimated 125 million tons of bituminous and anthracite reserves in widely scattered areas throughout the United States; reserves valued conservatively at a half-billion dollars. And the cost of 21 projects to date has been less than a cent a ton. In addition, millions of dollars worth of public and private property, including thickly populated residential areas, have been relieved of danger from subterranean blazes.

For years geophysicists were tabulating the number of fires burrowing through inactive deposits in the nation's most important coal-producing sectors. Their present report names 81 serious mine fires, mainly in Colorado, Wyoming, Utah, New Mexico, Arizona, and the 17 eastern coal states around Pennsylvania.

With money available, in April, 1949, the original Bureau task force was ready to go to work on the Wheeler seam fire near Rifle, Colorado. Greatest concern here was over the fire that three years earlier had begun chewing deep into a mountain on federal land. "If prompt action isn't taken," warned J. H. East, Jr., the Bureau's regional director at Denver, "we may lose our last chance at extinguishing this one."

Co-engineers H. W. Russell and R. L. Bolmer pulled out their recommendations, and it was decided to first determine the specific borders of the fire by drilling test boreholes into the seam at numerous points and then have the actual choking operation

A fire in underground workings near Coalmont, Colo., was isolated by the U. S. Bureau of Mines. The coal bed, ranging from 22 to 35 feet thick, forms the wall of this trench.

done by a private contracting firm in the area.

East and his associates had to decide which of three practical job methods would pay off fastest and cheapest: (a) surface sealing—packing a 10 foot sheet of soil over the smoking area; (b) isolation—plowing a trench around the burning segment and jamming this with incombustible matter thereby letting the fire burn itself out; or (c) flushing—stuffing masses of silt directly into the heart of the hot bed through boreholes.

In any case it was going to be risky business; they'd have to work across the face of a mountain that pitched steeply to a thousand feet. And the sensitive overburden on the hot zone—heat-wrinkled rock and soil, sagging like a hammock—might cave in at any moment under the weight of construction machinery.

Topographically, surface sealing appeared the most practical plan, and the engineers handed the earth-moving contract to the Louis Pinello Company, a heavily mechanized outfit from Colorado Springs.

For the next three months, bulldozers, tractors, rippers and trucks worked the area, pausing repeatedly for blasting, then chaining themselves one to another to ease into sudden declines or onto the cracked overburden that looked as formidable as thin ice on a pond. Essentially, the campaign called for dynamiting and gashing a 75-foot pit across the 4½ mile bed to snap its continuity. "We'll dig down until we hit cold coal," East announced. So out came 28,885 cubic yards of stone and earth, and back went 3500 of clay, punched into the pit by bulldozers.

Cost? Down to the last nickel, $39,867.05—and when compared to the saving, enough to gladden a recluse.

Similar projects came in fast succession. At Coalmont, Colorado, sealing off a 40 foot seam of 5 million tons cost $57,751; San Juan, New Mexico, 4½ million tons at $30,000. In Teckla, Wyoming, a bed of 90 feet promises 15 million tons, at $72,030. A 30-year-old fire in Converse County, Wyoming, had consumed 750,000 tons but will now yield 30 million. Proudest of all are engineers who spent only $6851, at Laur, Wyoming, to conserve 5 million tons.

Expenses run somewhat higher in the eastern fields, like 2 million tons spared at $39,529 in Schuykill County, Pennsylvania. But values in this area outdistance the Western majority, since these fields cover more precious anthracite reserves. While in the west the fire-control works are being carried out invariably on public lands with the Government footing the entire bill, in the Appalachian sphere nearly all are on privately owned lands. Here the Bureau pays one-third, the remainder coming either from the mineowners or city, county, or state funds.

Why Save Coal?

But why all the excitement over how much coal the new underground firemen can save? Geologists claim that about half the world's supply lies in 340,000 square miles of the United States, and at present rates of consumption there is enough left for at least 400 years—or conceivably twice that.

Enough left, yes—but the grade and the economic availability of the vast acreage are the questions worrying conservationists and miners themselves, who are painfully aware that close to 30 per cent of

the best mines in the anthracite districts of Pennsylvania are already exhausted.

Less than 100 Years

Meanwhile, as the nation's greatest concentration of hard-coal mining continues in that state's four fields, none is accorded even 100 years more life. For the northern and eastern fields, geologists forecast less than half that.

Taking the east as a whole, A. G. Crichton, a mining expert, told the American Institute of Mining and Metallurgical Engineers, in 1948, "Ninety-two per cent of the coal is produced and used in this highly industrialized area. On this basis, I would say that there are only 90 years of supply left."

Authorities point out other serious facts aimed at scuttling any callous outlook for our "tremendous coal reserves." For every ton taken, another has always been lost in mining wastage. Still we are demanding 10 per cent more anthracite than in the pre-war years. Further, mine operators are almost exclusively "working out" the most profitable and most accessible beds. As 70 per cent more of these lush deposits are depleted, the only alternative will be to harvest deeper, more dangerous, and poorer veins. These seams may be so deep and hold so little worthwhile yield that costs might prohibit their use.

Gasoline From Coal

As for the subsequent value, E. R. Nicolai, of the Bureau's Pittsburgh office says, "The Department of the Interior is all the more appalled by the loss of coal to date, and anxious over some 120 million tons known still to be threatened, because it recognizes that coal some day will be called on to fill a huge new gap that most people aren't aware of yet. This gap will exist between our supply of natural petroleum and our growing thirst for gasoline. Farsighted researchers have begun experiments aimed at demonstrating to industry how it can convert coal into gasoline, diesel fuel, jet fuels, and other products vital to the future economy."

A million tons of coal destroyed in an ignored fire translates into a startling loss of 150 million gallons of gasoline.

How, by the way, do these fires originate? While gas formations and spontaneous combustion with the help of fanning winds do play culprit roles, the sorry fact is that a great many fires start by the carelessness of campers and the public and private use of abandoned strip mines for garbage dumps. The tiniest smoulder gradually sneaks back to a thick vein, and a half-century fire may be born. In some cases, brush and grass fires lick an unknown bed that has nosed itself through the ground. If such outcrops are detected, residents or travelers over the area are cautioned. But then it takes only one link of laxity to launch a chain of longlasting ruin.

In the sparsely populated west, the eventual menace may be of less overall consequence. In Pennsylvania, Ohio, Maryland, and West Virginia, however, a new significance is attached to the fire-fighting tasks.

A typical instance was Kulpmont, Pennsylvania, which was shocked to its soles two years ago when geologists paid a call. The city had just finished building a million-dollar high school.

"It hurts us to tell you this," the geologist said, "but a fire is right now creeping straight for the school and the housing area nearby. It's within 150 feet."

The money-short officials appealed to the state for help, and the necessary $105,000 was granted. But it took ten anxious months to work out the lengthy arm of glowing coal and erase the final spark of danger.

Cities Endangered

In several other communities, including a sector of Pittsburgh, the coal that had brought prosperity now was delivering jeopardy. A fire threatening 75 homes, a plant, and the main-line track of a railroad near Latrobe, was snuffed out early in 1951. Another school and residential development faced destruction at Monessen, before the fire fighters invaded the troublesome deposit. There were several roads and cemeteries endangered in Shamokin. Luck was on the side of homeowners in Carbondale, who were unaware that fire had already eaten out a cave beneath them. A well-to-do Fairmont, West Virginia, residential plot was saved in the nick of time.

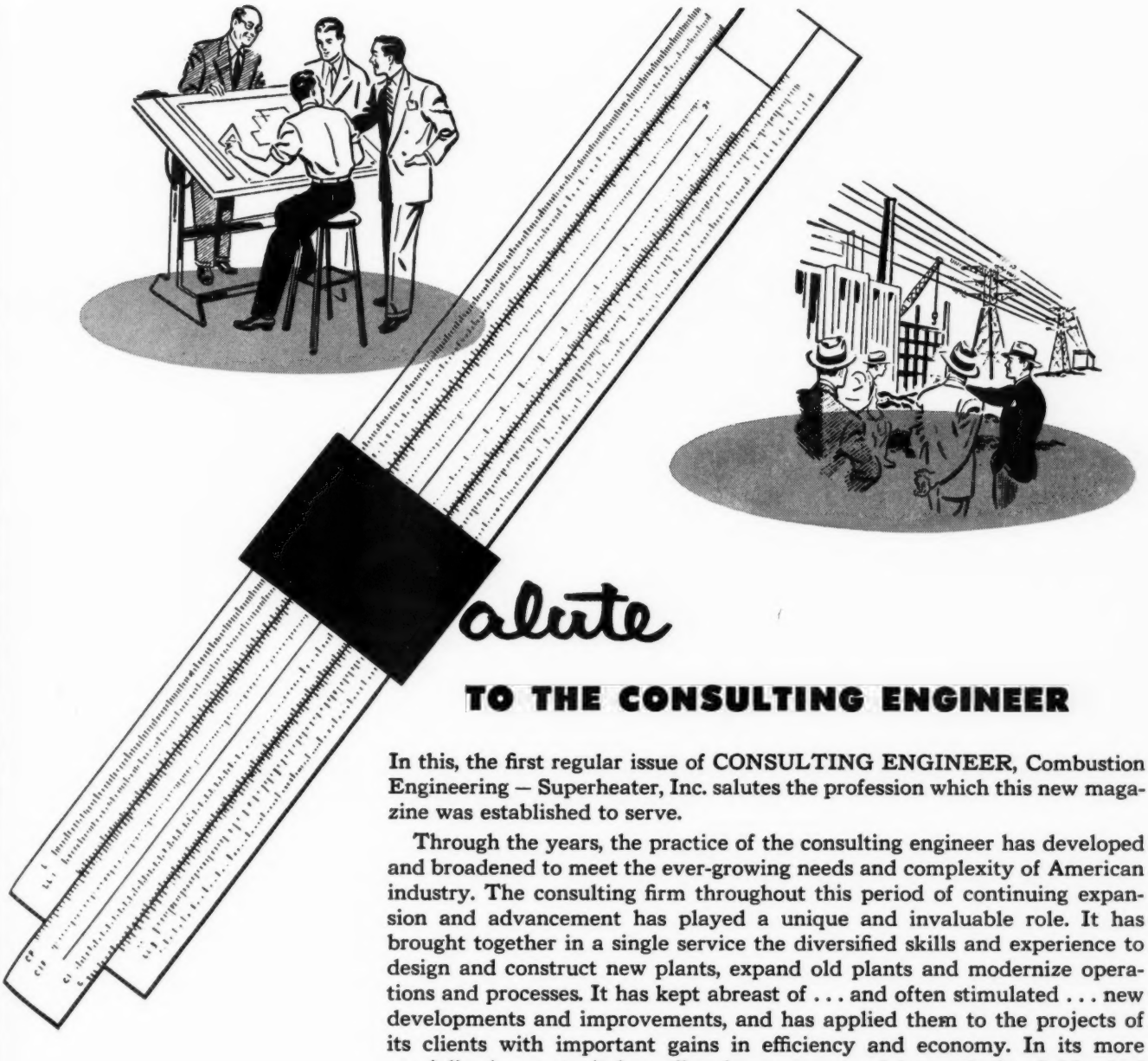
Of the most critical fires presently gnawing through inactive beds in densely inhabited regions in the east, 46 are in Pennsylvania, 9 in West Virginia, 5 in Ohio, and 1 in Maryland. Records at the Pittsburgh Division of the Bureau frankly reveal the peril:

". . . will endanger reforested land, some dwellings, and oil wells." "Inhabitants complain of fume hazard." "Fire threatens to undermine county road." "Burning 50 years or more, reducing property values." "Active near another housing district." "Near 50 homes." "Approaching 70 to 80 homes."

These disclosures are random choices, the real list is expanding constantly if slowly.

Legislation Needed

Many considerations, both technical and financial, tax the selection of the next most serious fire, and the remainder must simply wait their turn. Limited staff is an obstacle, but the truth is that the Bureau can move only as fast as Congressional appropriations permit it, year to fiscal year. The total granted to date is slightly more than $1 million. The Bureau estimates six times that amount is needed, and despite the far-reaching significance promised by the first successes of these fire fighters, no act granting the urgently needed liberty to the Bureau has yet been proposed.



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TO THE CONSULTING ENGINEER

In this, the first regular issue of CONSULTING ENGINEER, Combustion Engineering — Superheater, Inc. salutes the profession which this new magazine was established to serve.

Through the years, the practice of the consulting engineer has developed and broadened to meet the ever-growing needs and complexity of American industry. The consulting firm throughout this period of continuing expansion and advancement has played a unique and invaluable role. It has brought together in a single service the diversified skills and experience to design and construct new plants, expand old plants and modernize operations and processes. It has kept abreast of . . . and often stimulated . . . new developments and improvements, and has applied them to the projects of its clients with important gains in efficiency and economy. In its more specialized aspects, it has offered expert counsel in particular fields. And to all these areas of service it has brought the perspective of wide experience and highly developed skills of analysis, evaluation, appraisal and correlation.

It is indeed fitting, then, that the profession of consulting engineering — from the large firm operating on an international scale to the small specialist type of organization — should have a magazine devoted exclusively to its affairs. Such a medium should not only serve the profession's particular journalistic interests but should also create a greater awareness of the essential role played by the consulting engineer in advancing the productivity and efficiency of American industry.

Combustion Engineering—Superheater is happy to publicly acknowledge its debt to the consulting engineering profession and its admiration for its contributions and achievements in the several fields with which C-E is identified.

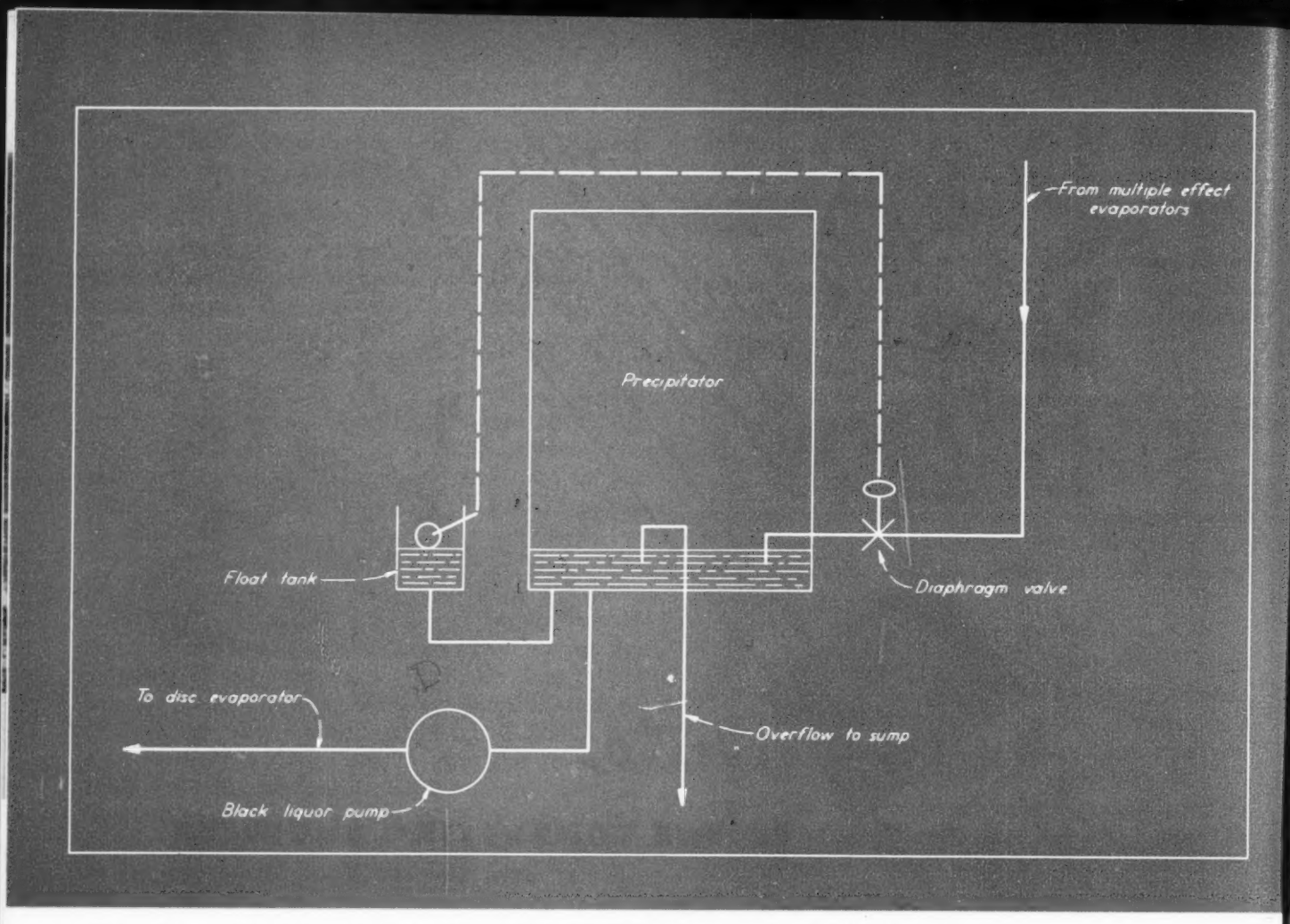
C-E

COMBUSTION ENGINEERING — SUPERHEATER, INC.

Combustion Engineering Building
200 Madison Avenue • New York 16, N. Y., U.S.A.

B-651

ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT



Flow diagram illustrates the wet bottom sump in precipitator for recovering black liquor

New Precipitators Cut Recovery Costs

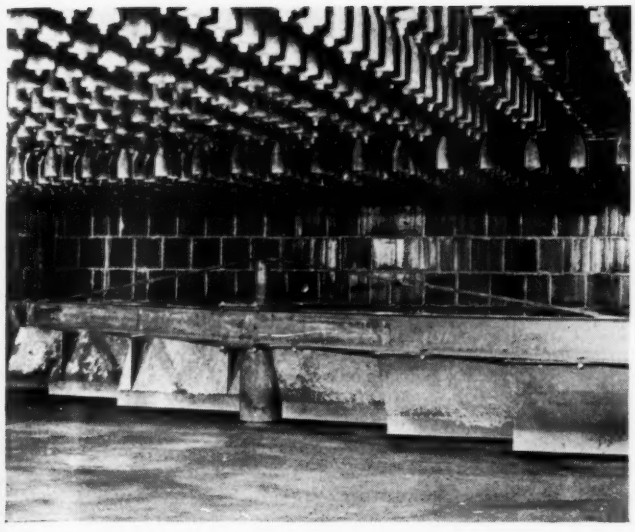
Salvaging suspended solids in flue gases by electrostatic precipitation has long been an inter-industry practice. But, now a new approach has been worked out in the pulp industry to cut time and costs in returning the collected material into the pulp making process. The black liquor itself carries the collected material to the recovery furnace. Precipitators using this new method are called *wet-bottom* types.

TABLE 1 — RECENT WET BOTTOM PRECIPITATOR INSTALLATIONS

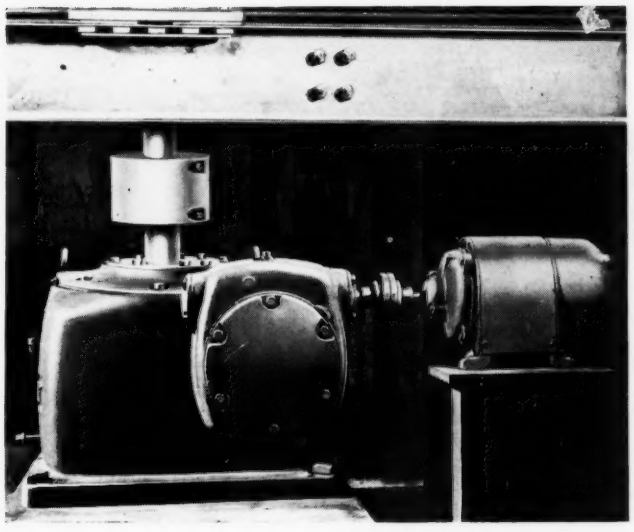
CFM through precipitator	Temperature F	Rated efficiency per cent	Application
81,000	300	90	Recover sodium sulfate gases from sulfate pulp
138,000	275-300	93	Salt cake recovery
138,000	275	93	Salt cake recovery
61,250	300	95	Sodium carbonate recovery
140,000	300	90.5	Salt cake recovery
140,000	300	90.5	Salt cake recovery
112,000	280	90	Recover sodium sulfate
100,000	300	90.5	Recover sodium sulfate
100,000	300	90.5	Recover sodium sulfate
160,000	275-300	90	Recover sodium sulfate

Standard practice in the paper industry was to handle the material in a dry state. Screw conveyers relayed the collected precipitate from the hoppers to the dissolving tank. But, this method required insurance against condensation, so steam jackets, heating coil units, and insulation materials for the screw conveyer became other needed extras. In addition, vibrators were necessary to prevent buildup and plugging in the hoppers.

Wet handling eliminates all these auxiliaries, thus reducing the initial investment and continuing servicing costs. Besides, in this method little time is lost in returning the collected materials directly into the pulp making process. The *wet-bottom* is a liquor sump or tank located below the collecting electrodes of the precipitator. Black liquor from the evaporators flows through this section and carries along collected dust. Motor driven rotary agitators circulate the liquor and facilitate solution or suspension of the dust. Black liquor from the multiple effect evaporators flows to the wet-bottom of the precipitator where it forms a liquid bath about one foot deep.



Sump chamber in lower portion of the wet bottom precipitator shows agitator and bottom of discharge electrodes



Motor and transmission for driving the rotary agitator is located directly below wet bottom section of precipitator

Liquor flow and level are controlled automatically.

Dust ladened black liquor flows by gravity to the pumps and to the disc evaporators. From this point it enters the smelter and dissolving tank.

Effectiveness of this method is seen by the lack of any substantial traces of solid material in the bottom of the liquor tank. Inspection of a typical installation showed only minor amounts of sediment of solid material remaining at the bottom of the liquor tank.

Basic design for paper mill practice includes a glazed tile shell filled with cement and reinforcing rods. Shell can be supported on structural steel or concrete wall. The collecting electrodes are rod curtain type made up of parallel rods supported in a frame to form plates. These plates are so spaced as to form ducts through which the gas passes in a vertical direction.

Discharge electrodes are suspended in the centers of these ducts from an insulated framework and held taut by weights at the bottom. Both collecting and discharge networks of electrodes are equipped with pneumatic vibrators to remove dust accumulations on the electrodes by rapping.

One typical installation has been made at the Mead Corp., Chillicothe, Ohio. Here the unit removes sodium carbonate from gases leaving a spray-type recovery furnace used in processing black liquor in soda pulp making. The furnace was designed to process approximately 525,000 lb of black liquor solids daily. At rated capacity the precipitator will clean 61,250 cu ft of gas at about 300 F with 95 per cent rated efficiency.

Under present mill operating conditions, 350,000 lb of black liquor solids are being processed daily with a gas volume through the precipitator of about 44,000 cfm at 270 F. Under these conditions, an efficiency in excess of 97 per cent is being realized.

At the Riegel Paper Corp. plant in Acme, North Carolina, another unit removes sodium sulphate from gases coming from a spray-type recovering furnace handling 750,000 lb of black liquor solids per day. On installation, the precipitator was designed to clean 112,000 cfm of gas at 280 F at a rated efficiency of 90 per cent, but operation reports show that actual recovery efficiency is 95 per cent.

TABLE 2 — AMOUNT OF DUST COLLECTED

Plant No.	Production ton pulp per day	Dust collected, lb per ton pulp	Makeup salt cake lb per ton of pulp: Prior to installation of precipitator	Makeup salt cake lb per ton of pulp: *After precipitator was placed in operation
1	225	88	246	158
2	250-300	100		
3	630	145	307	163
4	300	117		
5	288	135	316	193
6	230	135	300	180
7	450	130	300	170
8	980-1120	110-120	225	132
9	225	94	350	256

These figures are based on reports from nine plants. They show average monthly returns under all types of operating conditions. In general, the returns show recoveries of 88 to 145 lb per ton of pulp, the average being 118 lb. Based on the average rate and a precipitator availability of 95 per cent, the yearly return from a 250 ton mill operating 350 days per year would be 4900 ton.

*Note savings in salt cake makeup after installation. Collecting results are not affected by new wet-bottom design. Basic collecting operation of precipitator is the same.

TABLE 3 — PRINCIPAL CHEMICAL COMPOUNDS PRESENT IN MATERIAL PRECIPITATED

Plant No.	Na_2SO_4	Na_2CO_3	NaCl	Na_2S	Na_2SO_3
1	71.67	23.41	1.0	—	—
2	85.0	10	—	—	—
3	75.5	22.8	1.97	—	1.28
4	86.4	8.8	2.3	—	—
5	14.1	73.14	5.62	5.44	—
6	18.3	43	—	—	—
7	85-90	5-10	—	—	—
8	48	26.0	—	—	—
9	87.9	2.6	0.562	3.3	—

MEN IN ENGINEERING

★ Through the formation of a new dept, all research functions of the Dravo Corp. and its associated interests are now consolidated at Neville Island where laboratory facilities are under construction. One project of the department includes a process for treating industrial wastes by oxidation to prevent stream pollution and, in some cases, to recover steam for power production and process heating. Head of the newly organized dept of research and development is W. L. Newhall, formerly asst genl mgr of the engineering works div. McAndrew McCall is named chief design engineer, construction dept, machinery div. His office is in the Dravo Building, Pittsburgh.

★ Dr. A. Kolstad, physicist with the U.S. Atomic Energy Commission in Washington since 1950, is appointed chief of the physics and mathematics branch in the AEC's div of research.

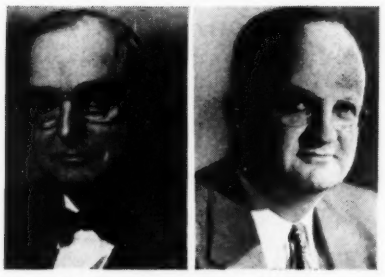
★ C. C. Zimmerman, v-p and chief engineer of the Benjamin F. Shaw Co., is named executive v-p.

★ The H. K. Ferguson Co. announces appointment of F. W. Daniels as v-p in charge of engineering. At the same time A. J. Maloney was named mgr of the Cleveland district.

★ S. L. Winslow, partner, A. T. Kearney & Co., is elected president of the MTM Association for Standards and Research. Other officers named at the annual meeting held in Chicago were A. C. Kleinschmidt, S. W. Steele and J. A. Willard, vice presidents; G. Chane, secretary; and P. Kellogg, treasurer.

★ The Harold F. Howard Co., Detroit industrial and management engineering firm has moved to larger quarters at 319 Fisher Building, Detroit 2, Michigan.

★ P. A. Potter, for the past 16 years senior engineer in charge of water supply and sewerage for the New Jersey Board of Public Utility Commissioners, has rejoined the staff of Buck, Seifert and Jost, consulting engineers, as an associate.



Spencer Quirin

★ Two well-known consulting engineering firms recently joined hands when Baker and Spencer, Inc. became affiliated with Frederic R. Harris, Inc. E. J. Quirin is named president of both firms. C. G. Spencer continues as a consultant and v-p of Baker and Spencer, Inc.

★ A recent project at Monsanto, Illinois, was the installation of a twin industrial sewer which serves a half-dozen industrial plants. Engineers were Architectural Engineers, Inc., of East St. Louis, Ill. with J. W. Goldenberg as consulting engineer.

★ Award of a contract to American Bridge Div. of United States Steel Corp. for fabrication and erection of the steel framework of the Prudential Insurance Company's new 41-story Chicago skyscraper is announced. Naess and Murphy, Chicago architectural and engineering firm designed the building.

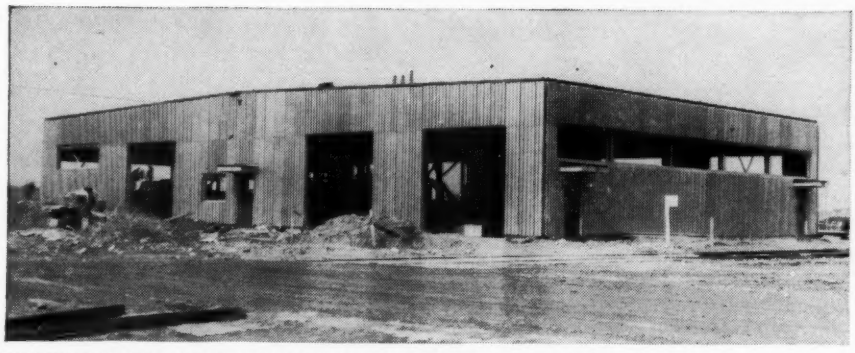
★ R. L. Bertin, consulting engineer, designed the new 88,000 sq ft plant being erected in Westbury, L. I. for John Hassall, Inc. Construction has been started by the Wininger Construction Corp.

★ Gilbert Associates, Inc. recently played host at a luncheon in Reading, Pa., to honor several distinguished guests, among whom were Hisagoro Mori, v-p of Kansai Electric Power Co. (seated left) and Masato Hirano, ass't to exec v-p of Kansai (seated right). Both reside in Tokyo. They were accompanied by J. D. Haight, ass't director, projects div of Westinghouse Electric International Corp (standing center). The visitors arrived here for a series of conferences with GAI executives—M. Duncan, seated center; R. Homan, standing left; and E. C. Edgar, standing right—in regard to economic and engineering problems relative to the initial phases of the Tanagawa Power Plant to be constructed in Japan. The plant will be American in design and will include Westinghouse generating and electrical equipment.

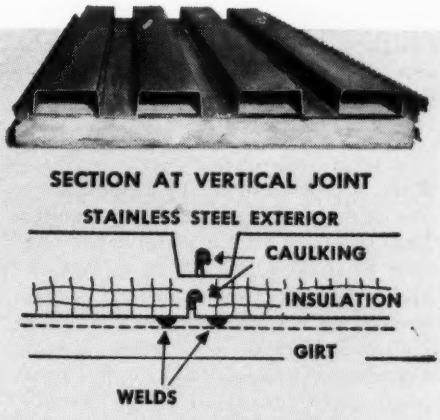
(Continued on page 76)

Insulated panels of U·S·S 17 (Type 430) Stainless Steel mean fast, low-cost construction at Fairless Works

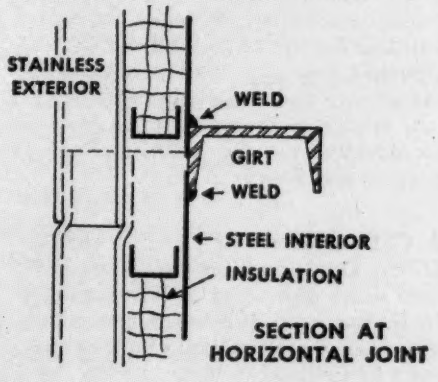
4005 sq. ft. of panels installed by crew of 4 in 8 working days



WORKING UNDER ADVERSE WEATHER CONDITIONS, a crew of four installed 4005 square feet of insulated Stainless Steel panels on this building in less than eight working days. Panels were manufactured by H. H. Robertson Co., Pittsburgh, Pa.; installed by R. A. Steelman Co., Trenton, N. J.; architects, Walter Kidde Constructors, Inc., New York.



THESE DETAILS of panel cross sections show methods of making horizontal joint (below) and vertical joint (above). Such methods of joining, combined with the low "U" factor designed into these panels, produce an exceptionally well insulated building.



CONSTRUCTION with insulated building panels of U·S·S 17 (Type 430) Stainless Steel is gaining considerable momentum in the field of industrial building—such as power plants, factory office buildings, warehouses, etc. Architects and owners alike have been quick to recognize the advantages of light panel weight, long building life, minimum maintenance, low labor costs and fast erection in any type of weather.

The building shown here is a Stainless-paneled fire station at the new Fairless Works of United States Steel Corporation at Morrisville, Pa. The 66′ x 100′ structure contains 4005 square feet of insulated panels of 20 gage U·S·S 17 Stainless Steel.

A crew of four men erected the panels under adverse weather conditions in less than eight working days. The prefabricated sandwich panels, consisting of U·S·S 17 (Type 430) Stainless Steel exterior, 1½″ of insulation and a coated steel sheet interior, were attached to the structural steel framework by spot welding, a fast and strong method of installation. U·S·S 17 (Type 430) is readily available without CMP tickets.

Note the cross-sectional sketches of the horizontal and vertical joints. As indicated in the sketches, caulking is applied to the vertical joints prior to erection. This provides an excellent vapor seal and is therefore instrumental in reducing the over-all "U" factor. The cross section of the vertical joint illustrates how the lower panel is counter sunk to gain a tight flush joint at the lap.

A new book containing the latest information on construction with panels of U·S·S 17 Stainless Steel is now being distributed. For your copy, use the coupon.

United States Steel Corporation
525 William Penn Place, Room 2808-K
Pittsburgh 30, Pa.

Please send me your new booklet on U·S·S 17 Stainless Steel for industrial buildings.

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Address.....

City.....State.....

United States Steel produces only the Stainless Steel sheet and strip from which panels of this type are made; the panels themselves are fabricated by a number of our customers.

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UNITED STATES STEEL

Men In Engineering

—*Starts on page 74*

★ M. Davis, v-p of Gilbert Associates, Inc. and of GAI-PAN American Corp., a Gilbert subsidiary, is making a routine tour of projects designed by GAI engineers, which are now under construction in Bogota, Medellin and Cali, Colombia, South America.

★ A. O. Beckman, president and founder of Beckman Instruments, Inc., officially broke ground for the new $2 million 200,000 sq ft factory and administrative offices to be erected on the 40 acre site in the La Habra-Fullerton area near South Pasadena, Calif. Details of the new plant were presented by L. Davidson of the Donald R. Warren Co., designing engineers.

★ Havens and Emerson, Cleveland, was consulting engineer on the recently completed sewage disposal building for the city of Akron, Ohio. Wrought iron pipe was specified for the sewage gas and air lines serving four sludge incinerators which were constructed by the Nichols Engineering and Research Corp.

★ C. G. Gay, v-p of The Babcock & Wilcox Co. announces that a tract of land south of the city of Wilmington, N. C. has been purchased and construction of a $2 million plant would start immediately. In answer to the growing number of inquiries as to how atomic energy would affect the company, A. Iddles, president, stated in his annual report, "The company has been active through the year in engineering and design studies for the use of atomic energy. Although it appears that the commercial use of atomic energy will not be economically feasible for some years to come, present plants for its utilization as a source of power require boilers and other equipment."

★ Alfred Hopkins & Associates, New York, and Metcalf & Eddy, Boston, architects and engineers for the Thule Air Base, Greenland, recently commended Luria Engineering Co. for the speed with which they fabricated and delivered to the point of embarkation, twelve service buildings with a combined floor space of 120,088 sq. ft.

★ Addition of C. H. Cook and J. C. Troy to the sales and service engineering staff is announced by Cyrus Wm. Rice & Co.

★ Dr. T. H. Chilton, technical director, engineering dept. of E. I. du Pont de Nemours & Co. is named new chairman of the engineering manpower commission of Engineers Joint Council.

★ Overend & Boucher, architects, in cooperation with Marietta Concrete Corp. engineers, have completed design plans for a new plant which will be located at Hollywood, Florida. A new firm, known as The Marietta Concrete Corporation of Florida, has been formed with F. L. Christy as president.

Charles A. Haskins, Kansas City, is consulting engineer on this $1 million sanitary sewerage project under construction at Independence, Mo. Included in this aerial view are the two clarifiers, the trickling filter and the digester. Control building is at right.

★ Dr. L. W. Bass, prominent industrial research executive, is now associated with Arthur D. Little, Inc. Dr. Bass will be primarily concerned with the increasing demand on the staff for consultation on the effective organization and management of industrial research activities. It is announced that the Little organization accepted a contract from the State Department to undertake an industrialization project in Egypt. Three of Little's industrial experts will, after a study of the country, advise and assist the government of Egypt in developing industries. The group is comprised of E. Stafford as field project manager and Dr. R. M. Alt as chief economist. A. G. Haldane accompanies the group for the first two weeks. Another member of the staff, C. Harford is now in Egypt to complete a housing project for the Government of Egypt. His work will be to supervise the making of a new type of brick and the construction of a few model homes.

Bass Value

★ B. R. Value of Seelye, Stevenson, Value & Knecht, is elected president of The New York Association of Consulting Engineers succeeding J. F. Hennessy of Syska & Hennessy, Inc. Other officers elected are V. L. Falotico of V. L. Falotico & Associates, vice president, and J. M. Pryke of Slocum & Fuller, secretary. H. H. Bond was re-elected treasurer of the organization. Elected to the executive committee, which also includes the officers, were J. F. Hennessy, Syska & Hennessy; D. Hunt, Krey & Hunt; and W. H. Eipel, Tuck & Eipel.

★ Dr. C. G. Veinott, well-known electric motor design engineer, inventor and author, has joined the Reliance Electric & Engineering Co., as consulting engineer on a-c machinery.

★ The General Engineering Co. Limited, Toronto, Canada, announces the opening of GECO Incorporated, with offices at 431 Bulkley Building, 1501 Euclid Ave., Cleveland. Manager is M. E. Hackstedde.

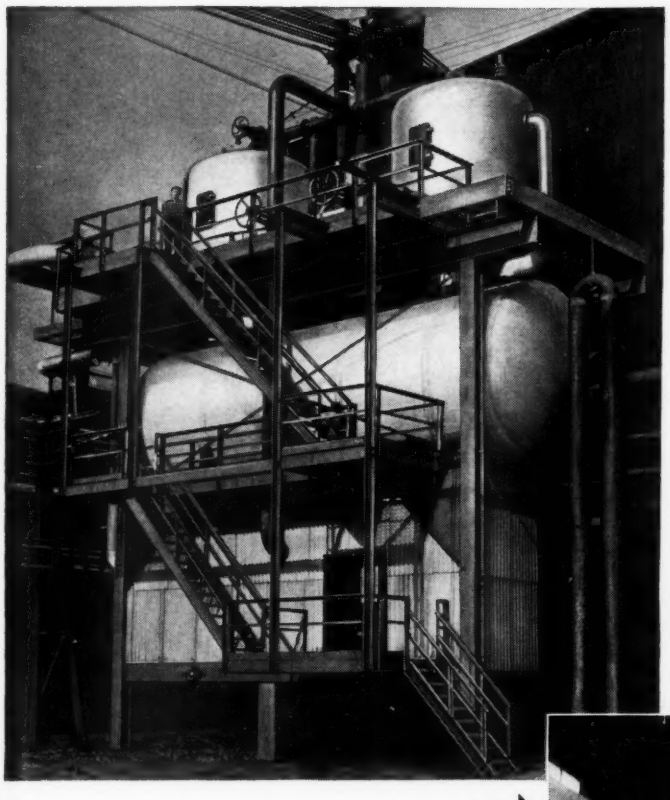
(Continued on page 86)

GRAVER

Deaeration for all!

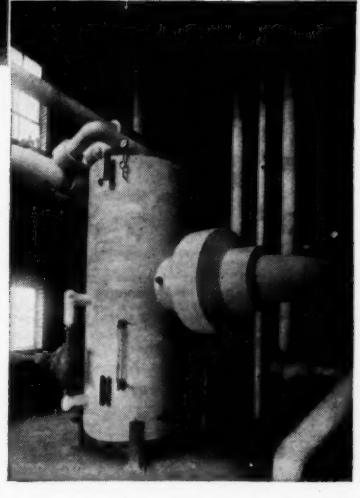
from under 5,000 lb per hr to over 1,000,000 lb per hr

Whether your plant is large or small, the wide range of Graver Deaerating Heaters assures a correct selection for your particular operating conditions. Graver Heaters are available in spray or tray types, or a combination spray-tray type, equipped with either external or internal vent condensers.



← For the large capacity plant

Graver Deaerating Heaters are serving high-pressure high-temperature central power stations and large industrial plants all over the country. Even with difficult operating conditions such as variable load and corrosive water, Graver installations uniformly exceed guarantees and operate with complete satisfaction, minimum attention, and negligible maintenance expense.



→ for the small capacity plant

Standard designs of Graver small Deaerating Heaters are specially engineered for the same low-oxygen guarantee carried by the larger and more expensive Graver Heaters. These small Graver units provide complete deaeration at a low cost that is quickly returned by savings in plant operation, maintenance and outage costs.

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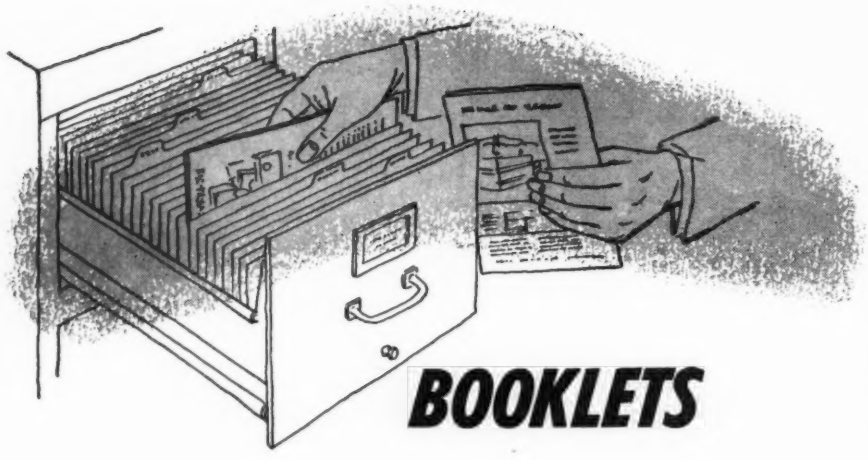


BOOKLETS

LABORATORY FACILITIES and research services of a new laboratory are discussed in 48-page booklet R10. Topics discussed include organization and operation within the laboratory, facilities, systems development, instrument development, and a listing of all laboratory equipment. The organization specializes in basic and industrial research, development, and instrumentation in such fields as servo-mechanisms and general electronics. *Cook Research Laboratories, Div. of Cook Electric Co., 2700 Southport Ave., Chicago 14, Ill.*

THE FUNCTION OF COLOR in decoration of commercial, industrial, and institutional interiors is the subject of a 4-page folder. A scientific method of color selection is presented, along with color chips of the system's 6 basic colors in varying degrees of intensity and light reflectance. Specifications and application directions for various types of coatings also are tabulated. *The Arco Co., 7301 Bessemer Ave., Cleveland 27, Ohio.*

MOVABLE WALLS—How space layouts can be made permanently efficient by mobilizing them with movable walls is discussed in 48-page brochure 53. Descriptions of various types of walls are presented, and numerous installation and construction photographs, detailed construction drawings, and specifications are given. Available accessories also are described. *The Mills Co., 965 Wayside Road, Cleveland 10, Ohio.*

ROLLING DOORS are the subject of 32-page bulletin 75. Various types are described, including steel rolling service doors, fire doors and shutters, folding doors, sectional overhead doors, steel rolling grills, and units for special applications. Construction features, advantages, specifications, and applications are presented. *The Kinnear Manufacturing Co., Columbus 16, Ohio.*

AERIAL SURVEYS and maps, as well as many other products that result from aerial photographs, are described in a 20-page booklet. Ways are discussed in which aerial mapping saves time and money on engineering projects. According to the booklet, aerial surveys can be used in almost every situation where ground surveys are used, and are not subject to accumulative errors or terrain limitations encountered on the ground. *Abrams Aerial Survey Corp., Lansing 1, Mich.*

"EQUIPMENT FOR BUILDINGS and Institutions," 20-page bulletin WP-1099-B27M, provides condensed information on many types of equipment. Included are air conditioning and refrigeration products; oil, gas, and dual fuel engines; deaerators; water conditioning; steam turbines and turbine-generators; liquid meters; centrifugal pumps, regenerative turbine pumps; vertical turbine pumps; and multi-V drives. *Worthington Corp., Advertising and Sales Promotion Dept., Harrison, N. J.*

MOVABLE STEEL fire partitions, designed to answer the need for one-hour fire protection in storage areas and special spaces in public buildings, schools, hospitals, laboratories, and factories, are described. The literature describes the product as the first one-hour movable steel fire partition to successfully meet Underwriters' tests. *Virginia Metal Products Corp., 1112 First National Bank Bldg., Pittsburgh, Pa.*

STEEL FRAMING, consisting of a series of cold formed channels and specially designed nuts and fittings which combine to form numerous types of framing construction, is discussed in 44-page booklet 153. Initial basic information on channels and fittings, including dimensioned drawings and engineering data, is presented. *Flexa Steel Products, Inc., 1348-50 West Washington Blvd., Chicago 7, Ill.*

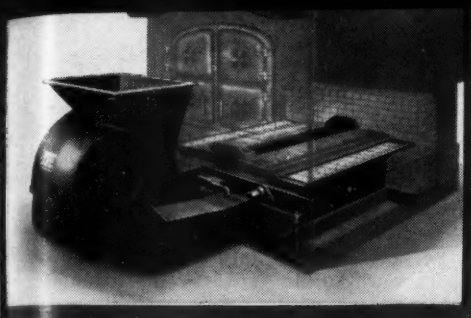
ENGINEERING PROGRESS WITH WOOD The outstanding papers presented at the Wood Symposium held during the Chicago Centennial of Engineering Convocation last fall, are compiled in a 120-page, illustrated book. It has been published as a record of information presented by recognized authorities on wood as an engineering and industrial material. Interesting topics include development of woodworking machinery, and factors effecting progress in virtually all fields of wood utilization. *Timber Engineering Co., Dept. WS-M, 1319-18th St. N. W., Washington 6, D. C.*

PORTABLE PHOTO-COPYER, and its uses, is described in a folder. The unit can be carried in a briefcase to permit its use wherever material to be copied is located. This is especially advantageous where documents, restricted material, or single editions cannot be moved from the premises. No darkroom or photographic experience is required. *F. G. Ludwig Associates, Deep River, Conn.*

"ALUMINUM IN ARCHITECTURE," 32-page booklet AD-262, discusses the architectural advantages offered by aluminum and aluminum alloys. Characteristics, selection of alloys, and finishes for architectural use are described. Performance records also are discussed. Particularly useful are sections discussing the use of aluminum products for curtain walls, unit spandrels, industrial building sheet, copings and gravel stops, window sills and thresholds, roofing, and for extruded architectural shapes. *Aluminum Company of America, 758 Alcoa Bldg., Pittsburgh 19, Pa.*

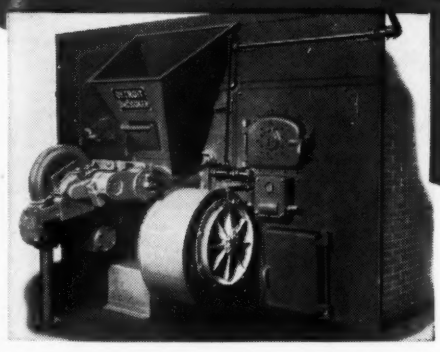
(Continued on page 80)

Personal copies of booklets can be obtained by writing directly to the manufacturers. Please mention this magazine. Thank you.

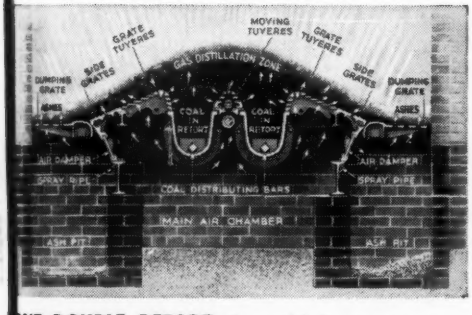


T UNISTOKER Single retort underfeed types and many sizes of boilers.

For any steam generator including package types use DETROIT STOKERS



ROIT UNISTOKER Single retort underfeed Adjustable Coal Feed Control.



OIT DOUBLE RETORT A multiple retort— cleaning underfeed for medium sized rs. No basement required for ash removal.

We build stokers adaptable to any type or make of boiler or steam generator. No matter what you are considering we can furnish the ideal stoker—the one that fits the furnace and is best suited to your operating conditions.

Detroit Stokers are successfully operating in thousands of boilers of different types, from firebox heating boilers to large steam generators of over 300,000 pounds of steam per hour, capacity. They are installed in private and public institutions, buildings, industrial and power plants, here and Abroad.

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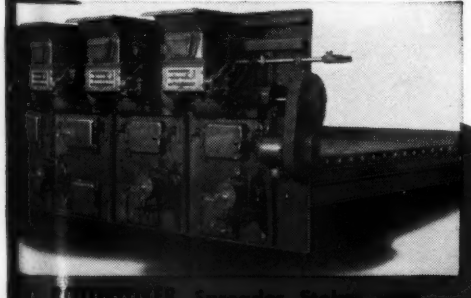
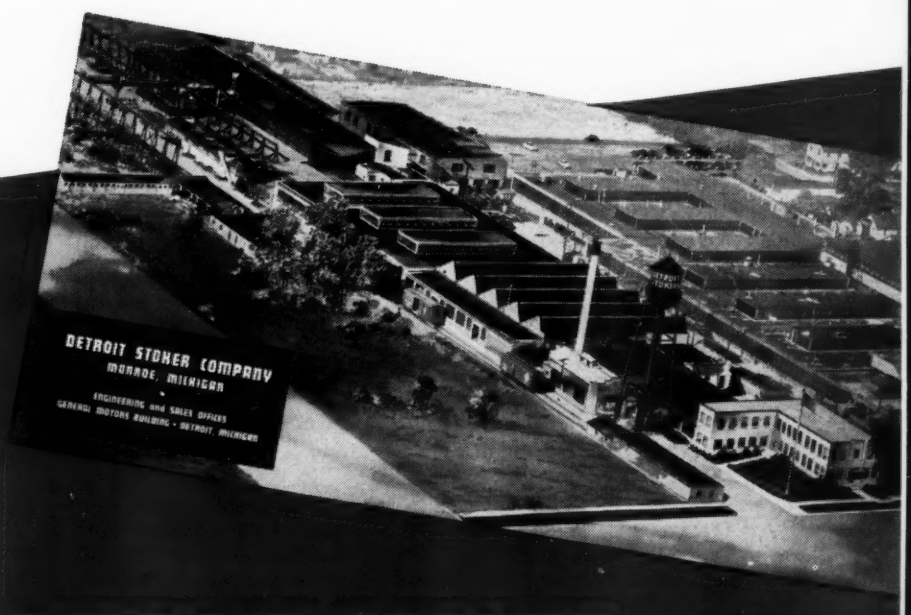
Each stoker that we design and build is assembled by experts in our plant and carefully inspected prior to shipment. You can't go wrong with Detroit.

Built to outlast the boilers that they serve, Detroit Stokers give you the best, most economical firing method for your needs. An informal discussion with one of our Engineers will cost you nothing and might save you a lot. May we hear from you?



ROTOSTOKER Spreader Stoker with Rotors. Burns wide range of fuel— Responding loads. Stationary Hand and Power Operated Grate Types.



ROTOGRATE STOKER Improved Spreader Grates move forward slowly and discharging the ash.

DETROIT STOKER COMPANY

DETROIT SINCE 1898 STOKERS

GENERAL MOTORS BUILDING, DETROIT 2, MICHIGAN

District Offices in Principal Cities . . . Works at Monroe, Michigan

BOOKLETS —Starts on page 78

CONCRETE DENSIFIER—The theory and practice of obtaining a good concrete is the subject of an 8-page bulletin. Beginning with the gel mechanics of cement-water reaction, it discusses factors affecting cement hydration and the basic quality of concrete. How these factors can be controlled to reduce cracking and increase concrete hardness and impermeability is discussed. How a concrete densifier works, typical applications, and results are discussed. *Sika Chemical Corp., 35 Gregory Ave., Passaic, N. J.*

SNOW MELTING SYSTEMS are the subject of a 40-page brochure. How the systems operate, actual installations, advantages, and operation are described. The advantage of using wrought iron pipe also is discussed. The major portion of the booklet is devoted to design of the systems. Formulas, tables, and charts are included in this section. *A. M. Byers Co., Clark Bldg., Pittsburgh, Pa.*

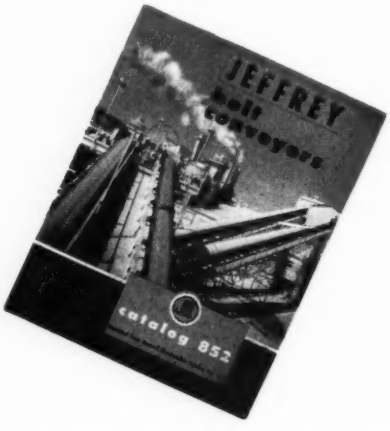
EXCAVATING EQUIPMENT — "Power Cranes, Shovels, and Drag Lines—Attachments, Traction, and Operation," 64-page technical bulletin 4, has been prepared to serve as useful text material for engineers and contractors dealing with excavating and earth moving problems. It discusses various attachments and outlines applications to which each applies. Data on application and effective use of these attachments, with the proper positioning of the basic unit for specific jobs encountered in the field, is presented. *Power Crane & Shovel Association, 74 Trinity Place, New York 6, N. Y. Price $1.00.*

"VERTICAL TRANSPORTATION," 24-page, 1953 general catalog A-382, describes vertical transportation equipment and services. Sections describe passenger and hospital elevators, escalators, dumb waiters, freight elevators, and elevator modernization and maintenance programs. Tables list recommended sizes and capacities together with other useful data. Modern systems of elevator control also are discussed. *Otis Elevator Co., 260 Eleventh Ave., New York 1, N. Y.*

AIR DIFFUSERS of the draftless aspirating type are the subject of 64-page selection manual 45. Useful tables of performance data are presented for each type of diffuser. Illustrations, tables of data, and case examples are used to show how to determine proper locations and correct number of units required. *Anemostat Corporation of America, 10 East 39th Street, New York 16, N. Y.*

"AIR POLLUTION SURVEYS," 4-page reprint, deals with the relationship between stream and air pollution surveys, and outlines procedures for making an air pollution field survey. It discusses the plan of sampling, the classification of pollutants, variations in sampling methods, and data required. *Office of Information services, New York University College of Engineering, New York 53, N. Y. Price 10¢.*

BELT CONVEYERS—Engineering data required to design a belt conveyer for any application are presented in 86-page catalog 852. The booklet, published to serve as a handbook on conveyer design, states that many problems can be answered by using



a standardized unit. These units have been indexed and classified to simplify selection. Description and data also are presented on such equipment as anti-friction idlers, belting, trippers, terminal pulleys, take-ups, and back-stops. *The Jeffrey Mfg. Co., Columbus 16, Ohio.*

TUBULAR DUST COLLECTORS are described in 8-page brochure 4P201. Contents also include a discussion of the problems of fly ash collection. Efficiency curves, arrangements, and standard dimensions are given. Flue gas density tables are included with a formula and nomograph for calculating the number of tubes required for any volume and resistance. Dimensions of a unit that satisfies space requirements can then be determined from dimension tables. *Pratt-Daniel Corp., 2 Meadow Street, South Norwalk, Conn.*

POWER ROOF VENTILATORS of various types are described in 16-page bulletin 3704. Applications and construction are discussed, and engineering information such as performance data and dimensions are presented. To aid in selection, tables of steam heating capacities, fan capacities, steam conversion factors, and air friction of coils and filters are presented. *American Blower Corp., Detroit 32, Mich.*

AUTOMATIC COAL SCALE for weighing coal as it is fed to boilers is described in 16-page bulletin 0352. Divided into five major sections, the booklet gives construction and operating details of: the belt feeder which delivers coal from bunker to weigh hopper, the weigh hopper, scale housing, operating levers, and accessories. A complete explanation of how the unit operates, and information on special features also are presented. *Richardson Scale Co., Clifton, N. J.*

INDUSTRIAL CONTROLS — Applications, construction, and advantages of numerous types of industrial controls are outlined in 32-page catalog F-3941-2. Included are many types of temperature and humidity controls, motor operated valves, and control motors. One page also discusses control terminology. *Barber-Colman Co., Rockford, Ill.*

ANNUNCIATOR SYSTEMS, what they are and how they operate, are the subject of 38-page bulletin 100. Component parts of the systems are described. Considerable information is included to aid in designing. The subject of layouts for hazardous locations also is dealt with. *Panalarm Products, Inc., 6312 North Broadway, Chicago 40, Ill.*

BUS DUCT, and how it is used to solve distribution problems arising from modernization, expansion, or new building programs, is discussed in 12-page booklet B-5835. Plug-in duct, low-impedance duct, weatherproof feeder duct and weatherproof low impedance duct are described. The use of prefabricated elbows, tees, cross-overs, and sliding-type cantilever hangers also is discussed. *Westinghouse Electric Corp., P. O. Box 2099, Pittsburgh 30, Pa.*

"INDUSTRIAL POWER DISTRIBUTION Idea Book," 28-page booklet GEA-5900, has been prepared as a guide on distribution practices in large and small plants. Among the topics discussed are: what to do when a choice of primary voltages is available; application of primary switches and circuit breakers; types and arrangements of primary cables; types of load center distribution systems; use of branch feeder switches, starters, and fuses; grounding of systems; how to calculate interrupting capacities; how to apply capacitors; and methods of obtaining economical d-c supply. *General Electric Co., Schenectady 5, N. Y.*

LINE TYPE PURIFIER—Steam, air, gas, and vapor are cleaned quickly and thoroughly with an improved line type purifier, according to bulletin 200. The unit is said to combine

(Continued on page 82)

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of Regulation.....

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There's a LESLIE Regulator for every temperature control problem—designed to meet the demand for accurate, reliable, constant temperature regulation.

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OFFICES IN PRINCIPAL CITIES

BOOKLETS —*Starts on page 78*

increased separating efficiency with a more simplified design. Operation, advantages, and construction are presented. Applications include cleaning steam from boilers to protect operating equipment; removing oil and moisture from gas lines between compressor stages; protecting steam ejectors, valves, and other expensive pipeline equipment; and cleaning exhaust steam for further use. *Purifier Div., V. D. Anderson Co., 1935 West 96th Street, Cleveland 2, Ohio.*

OIL HYDRAULIC OPERATION of industrial machinery, and its advantages, is discussed in 56-page booklet 5001. Features and specifications are given for pressure control, volume control, and directional control valves, as well as balanced vane type and axial piston type pumps, and hydraulic motors. *Vickers, Inc., 1400 Oakman Blvd., Detroit 32, Mich.*

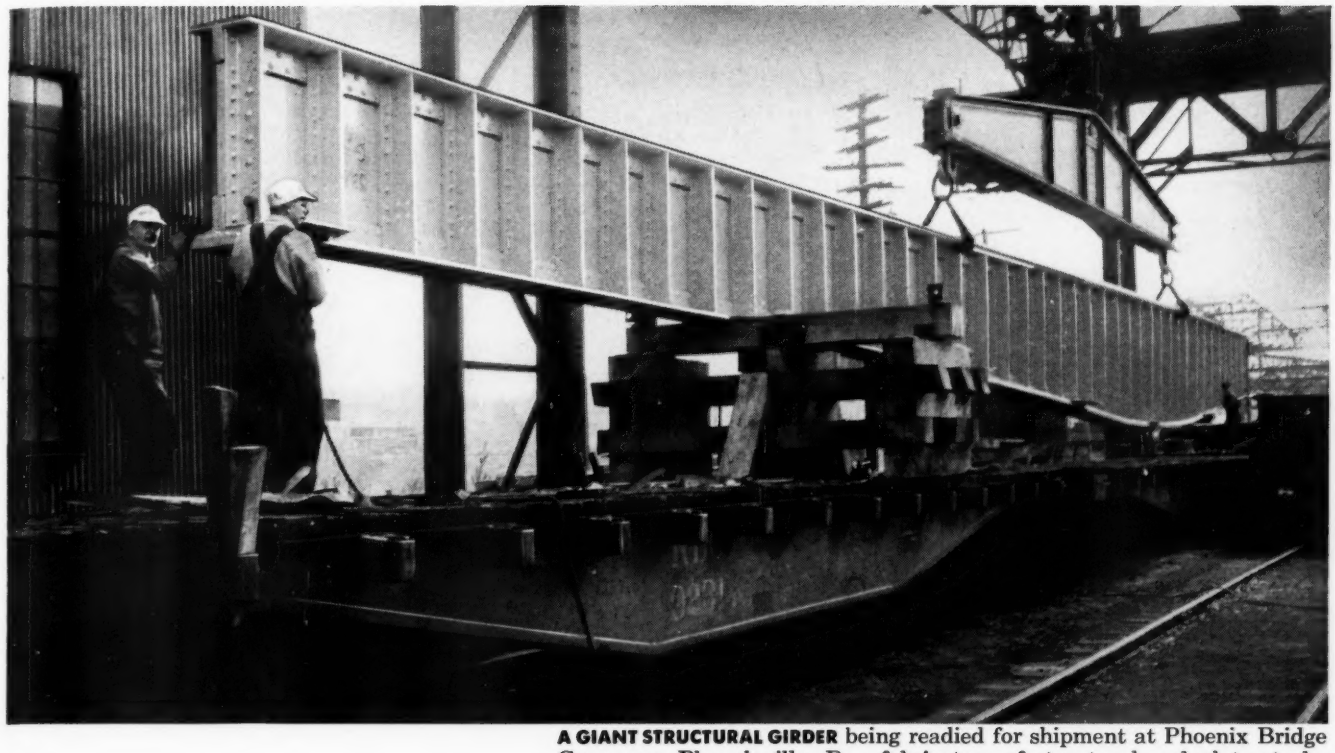
WATER HEATERS and coolers of various types are described in an 8-page brochure. Diagrams are used to explain how each individual unit functions. In addition to product descriptions, the literature contains tables dealing with heater selection, sizes, and capacities. *Manning & Lewis Engineering Co., 28-42 Ogden Street, Newark, N. J.*

ALLOY PIPE AND TUBING—One of the alloy tubing steels widely used in elevated temperature service is discussed in 4-page folder TDC-146. The mechanical properties of annealed and heat treated types, physical properties, and maximum allowable working pressures are tabulated. Fabrication also is discussed. *Tubular Products Div., The Babcock & Wilcox Co., Beaver Falls, Pa.*

INSULATED WALL construction for industrial furnace enclosures is described in a 12-page bulletin. Photos and engineering drawings show how thin insulated walls are used for boilers, refinery heaters, dryer furnaces, and kilns. *Bigelow-Liptak Corp., 2550 W. Grand Blvd., Detroit 8, Mich.*

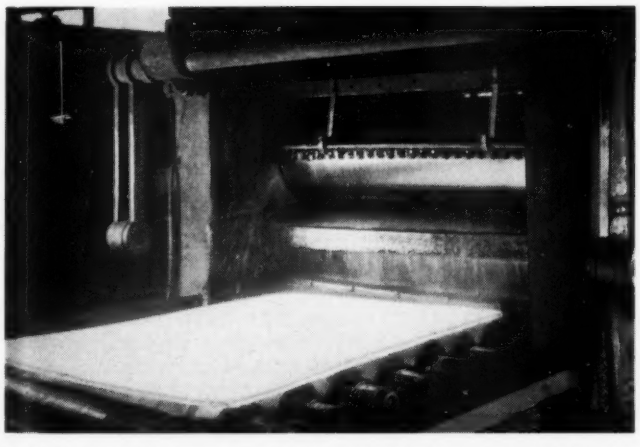
SPRAY-APPLIED INSULATION—The degree of protection from condensation which is afforded by a spray-applied cork and mastic insulation is shown in a series of charts. The coating is described as providing a moderate amount of insulation as well as protection from corrosion. Recommended applications include pro-

(Continued on page 84)



A GIANT STRUCTURAL GIRDER being readied for shipment at Phoenix Bridge Company, Phoenixville, Pa., fabricators of structural and plate steels.

You name it . . . we make it!



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In addition, Barium maintains a staff engineering force that is ready and able to assist you with any specific construction problems. Write us about your construction needs. Barium Steel Corporation, 25 Broad Street, New York 4, New York.

STANDARD AND SPECIALLY DESIGNED BOLTS are made by Bayonne Bolt Corporation and Erie Bolt & Nut Company for virtually every fastening need.

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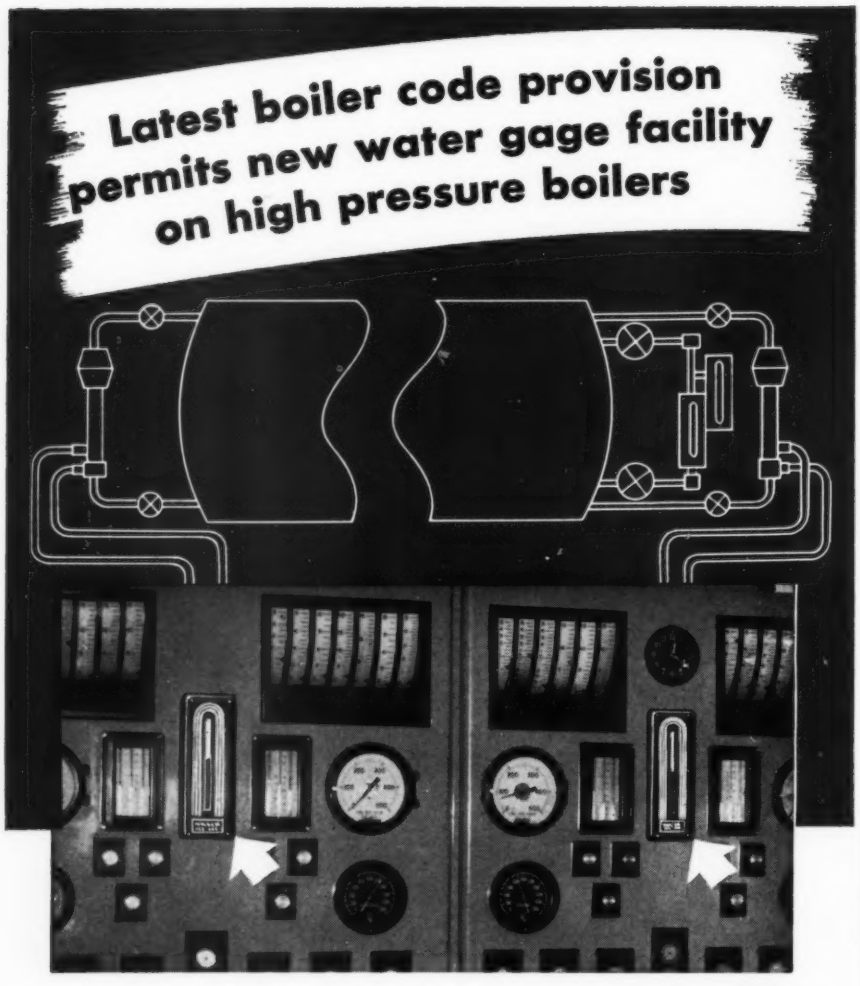


Now two EYE-HYE Remote Gages give you the required double check on pressures 900 lbs and over

Two independent remote level indicators of the compensated manometric type may now be used instead of one of two gage glasses required on pressures 900 psi and over. You still must have one conventional type gage, maintained in serviceable condition, but it may be shut off while both remote indicators are in operation.

This is a tremendous advantage. It removes the need for checking high gages, maintaining mirrors or other water level reading methods. EYE-HYE's sharp, illuminated indication is frequently reported as more accurate than gages at the drum. Now the two gages required can be at eye height—convenient, safe—a true double check on the vital boiler water level.

For full details of the new code interpretation read Case No. 1155. For information about Reliance EYE-HYE, call your Reliance representative or write for Bulletin CO.

The Reliance Gauge Column Co. 5902 Carnegie Ave., Cleveland 3, Ohio

BOOKLETS —Starts on page 78

tection of heated storage tanks and control of condensation on cold pipes and vessels. Charts give dew point for uninsulated pipe and for surfaces with ¼ and ⅜ in. sprayed insulation. Surface temperature of the insulation also is tabulated. *Insul-Mastic Corporation of America, 1141 Oliver Bldg., Pittsburgh 22, Pa.*

ROTARY GEAR PUMPS are the subject of 36-page booklet 3060, entitled "How To Solve Pumping Problems." Problems are discussed and sample solutions are presented. The major portion of the book is intended to serve as a data handbook. Nomographs of friction loss in pipe, resistance of valves and fittings, and viscosity of oils are included, together with tables of viscosities and specific gravities, conversion tables, electrical data, and lists of construction materials used for pumps handling a wide variety of materials. *Geo. D. Roper Corp., Rockford, Ill.*

HEAVY DUTY ROTARY PUMPS are described in 16-page bulletin W-483-B2. Construction and specifications are given for herringbone gear types with capacity to 5000 gpm and pressures to 500 psi, and sliding vane type to 1000 gpm and 200 psi. Fields of application and typical driving arrangements are discussed. A useful data section includes a viscosity conversion table, relation of API hydrometer scale to specific gravity, and a viscosity-temperature chart for fuels. *Reciprocating Pump Div., Worthington Corp., Harrison, N. J.*

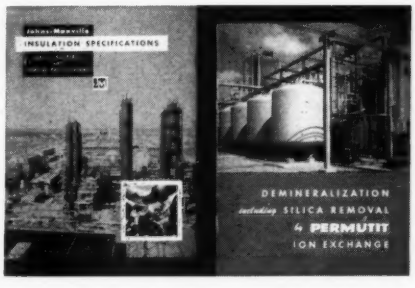
REGULATORS—"How To Select Regulators," a 40-page booklet, provides useful data for simplifying the selection of the proper type and size of pressure regulator, temperature regulator, or pump governor to do a specific job. Also presented are steam, gas, and water capacity tables, installation suggestions, and other useful information. *Foster Engineering Co., Union, N. J.*

SHIELDING ROOMS developed to suppress R-F interference caused by testing of electrical and electronic equipment, are described in an 8-page brochure. Various types and sizes are listed, including a double shield, multi-cell type; a double shield isolated cell type; and a single shield type. Construction details and installation are discussed. *Shielding, Inc., Riverside Park, N. J.*

CAST STEEL VALVES—To aid engineers in selection of valves, 56-page booklet 12-C contains useful information on material specifications,

preparation of welding ends, flange facings, and pressure-temperature rating. Construction and specifications for globe, angle, and check valves, in 300, 600, 900, and 1500 lb pressure classes are presented. Parabolic disc valves with hand or motor control also are discussed. *Edward Valves Inc., 2100 West 145th Street, East Chicago, Ind.*

INSULATION SPECIFICATIONS—Engineers who must specify thermal insulations in oil refineries and chemical process plants should find a useful source of quick reference in 52-page brochure IN-128A. Specifications are listed for thermal insulations on various types of equipment. Seven tables list recommendations for thickness. Also described is a complete service, including materials, engineering, and application. *Johns-Manville, 22 East 40th St., New York 16, N. Y.*



"DEMINERALIZATION Including Silica Removal By Ion Exchange," 28-page booklet 3803, has been prepared to help explain one of the newer rolls that ion exchangers are playing in industry. Described are applications, principals of operation, design features, advantages, recommendations, and specifications for demineralizing and silica removal apparatus and synthetic resins. *The Permutit Co., 330 W. 42nd St., New York 36, N. Y.*

IMPULSE STEAM TRAPS are described in 4-page folder T-1745. Construction and advantages are discussed. Units are listed for maximum continuous discharge to 37,400 lb per hr of condensate. Dimensions and materials of construction also are given. *Yarnall-Waring Co., 109 Mermaid Ave., Philadelphia 18, Pa.*

DEAERATING HEATERS—Discussed in a report entitled, "Experiences with Applications of Deaerating Heaters and Feedwater Cycles," are many different methods of adapting such equipment to a wide range of conditions. Flow charts, diagrams of selected design, and tabulation of results are presented. General explanations of various types of equipment and their characteristics are given. *Graver Water Conditioning Co., 216 West 14th St., New York 11.*

This NEW METHOD DRIES AIR

PRECISELY as you want it

- to control your product's quality
- to prevent condensation on your product or material
- to prevent changes due to moist air in contact with your product
- to protect your material from dampness
- to protect your processing of moisture-sensitive material
- to DRY your material or product
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- to get exact moisture control for the precise atmosphere condition you need
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The Niagara's Controlled Humidity Method using HYGROL moisture-absorbent liquid is

Best and most effective because . . . it removes moisture as a separate function from cooling or heating and so gives a precise result constantly and always. Niagara machines using liquid contact means of drying air have given over 20 years of service.

Most reliable because . . . the absorbent is continuously reconcentrated automatically. No moisture-sensitive instruments are required to control your conditions.

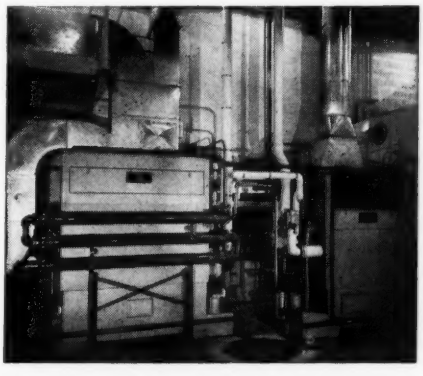
Most flexible because . . . you can obtain any condition at will and hold it as long as you wish in either continuous production, testing or storage.

Easiest to take care of because . . . the apparatus is simple, parts are accessible, controls are trustworthy.

Most compact, taking less space for installation.

Inexpensive to operate because . . . no re-heat is needed to obtain the relative humidity you wish in normal temperature ranges and frequently no refrigeration is used to remove moisture.

The cleanest because . . . no solids, salts or solutions of solids are used and there are no corrosive or reactive substances.



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This method removes moisture from air by contact with a liquid in a small spray chamber. The liquid spray contact temperature and the absorbent concentration, factors that are easily and positively controlled, determine exactly the amount of moisture remaining in the leaving air. Heating or cooling is done as a separate function.

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*69 pages of engineering reference notes on maintaining metal in power, manufacturing and service-industry equipment

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Men In Engineering

—Starts on page 74

★ D. A. Davenport is appointed chief engineer of Associated Research, Inc., Chicago firm of consultants, designers and engineers.

★ A. P. Woody is appointed a consultant in steam generation, combustion and boiler process heating for Eggelhof Engineers in Houston. E. L.

Woody Moore

Moore formerly with the Submarine Signal Co. in Boston, is now sales engineer for the Dallas office.

★ Dr. R. C. Ulmer, well known in the power field as a feedwater specialist and for the last seven years technical director of E. F. Drew & Co., has joined the engineering dept of Combustion Engineering-Superheater, Inc.

★ W. G. Christy, until recently Director of the Bureau of Smoke Control, City of New York, announces that he has severed his connection with the city and opened an office as consulting engineer at 34 Park Row, New York. In his announcement, Christy states that he is specializing in problems of air pollution control, combustion and smoke control.

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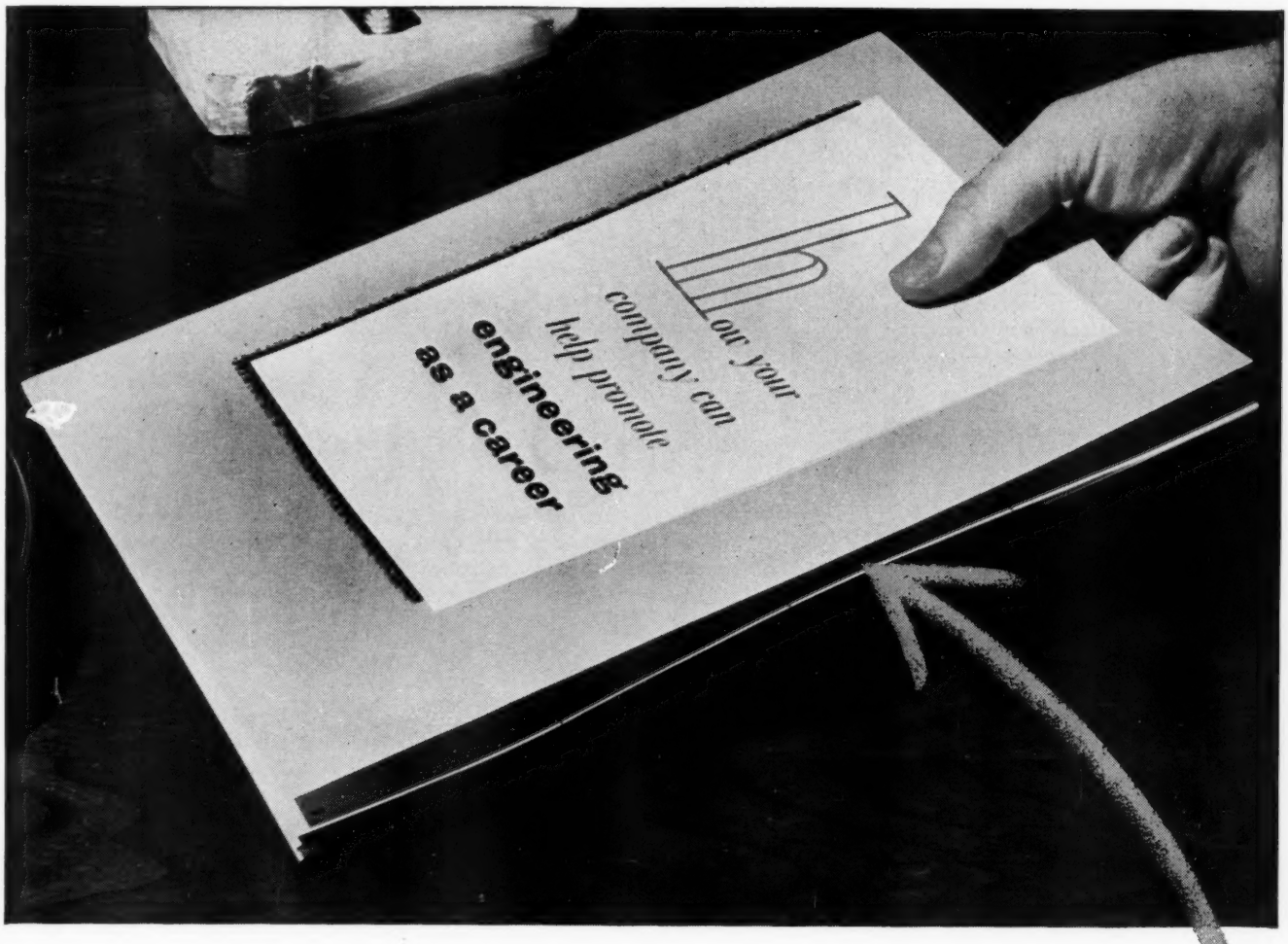
Professional card listings, one column wide (three columns to the page), and one inch deep will be available in future issues of CONSULTING ENGINEER. Rates have been set at $10 per listing per issue for transient advertisements. On contract basis of 12 consecutive listings, rate is $100 per year, payable monthly if desired. Please send all listings to: Classified Advertising Department, Consulting Engineer, 420 Main Street, St. Joseph, Mich.



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How to select, use, and maintain the right...

CONTROLLERS FOR ELECTRIC MOTORS

By Henry Duvall James
Consulting Engineer
and Lewis Edwin Markle
Manager Equipment Div.,
Control Eng. Dept.,
Westinghouse Electric Corp.
2nd ed., 418 pp.,
312 illus., $7.00

THIS new book takes guesswork out of controller purchase—shows you what kinds of controllers are available—how to select them to suit specific needs. It covers the whole field of electric motor controllers, both manual and automatic acceleration types—explaining details, advantages, limitations, and uses of most commercial motor control. Discussions include Faceplate and Drum, Cam, Magnetic Contactor, and Liquid Controllers. Hundreds of diagrams, illustrations, curve charts, tables—and simple, direct explanations—give you all the important details on design, use, and maintenance.

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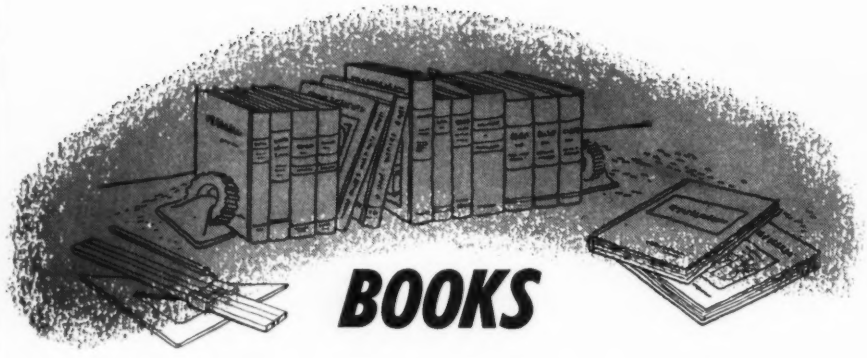

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HYDRAULIC RESEARCH IN THE UNITED STATES, edited by Helen K. Middleton and Sonya W. Matchett, National Bureau of Standards, Miscellaneous Publication 205, 200 pages, $1.00. The U. S. Government Printing Office is the source of a seemingly limitless flow of published material, much of which is of genuine technical value. Government publications are frequently overlooked despite the fact that the data presented would make an important addition to any technical library. Furthermore, publication prices are extremely reasonable.

As an example, *Hydraulic Research in the United States* is a well edited book compiled from reports on current research projects of 100 hydraulic and hydrologic laboratories in the United States and Canada. Anyone connected with a hydraulic development project should have this material so that he might know what other research groups are doing. More complete dissemination of this type of information would eliminate much of the overlapping work now being done in research departments.

In this publication, the projects are listed under the name of the research agency. In each listing a short description is given which tells the aims of the project and its progress and extent.

The volume also includes a list of foreign publications and translations on hydraulic topics which are available on loan from laboratories.

A similar bulletin, *Hydraulic Research,* has been compiled and published by the International Association for Hydraulic Research, and it contains information on projects being conducted in foreign countries.

Still another bulletin, *Directory of Hydromechanics Research Projects in the United States Related to Naval Architecture and Marine Engineering,* has been prepared by the Hydrodynamics Committee of the Society of Naval Architects and Marine Engineers. Copies of this publication may be obtained by addressing the secretary of that society at 29 West Thirty-ninth Street, New York 18, N. Y.

CHEMICAL INVESTMENTS, by John F. Bohmfalk, Jr., Chemonomics, Inc., 87 pages, $5.00. This is a small paperbound, cheaply printed publication which at first glance does not appear to merit a sincere review. In this instance, the first glance is deceiving. The publishers, Chemonomics, Inc., is an organization affiliated with R. S. Aries and Associates, Consulting Engineers and Economists. This market study of the chemical industry was originally intended for distribution only to clients and special groups.

The author, John F. Bohmfalk, Jr., is one of the pioneer chemists who specialized in investments after a career which included working for the Office of Rubber Reserve, and employment as an editor of American Chemical Society, *Chemical and Engineering News,* and *Industrial and Engineering Chemistry.* Currently, he specializes in investment analyses of chemical process industries for Clark, Dodge & Co., an investment firm.

The volume, despite its slim makeup, should be worth considerable more than its publication price to any consulting engineer interested either directly or indirectly in the future of the chemical industry. It points out the rate of growth in specific areas of the chemical process industries and examines the possi-

bilities of continued growth in the light of research activity. The author examines critically and frankly the competitive status of various companies in the chemical industry—such companies as du Pont, Mathieson, Monsanto, Dow, Merck, and their allies and competitors.

An appendix gives detailed financial information on each company analyzed.

HEAT TRANSFER PHENOMENA by R. C. L. Bosworth, Associated General Publications Pty, Ltd., distributed by John Wiley & Sons, Inc., 212 pages, $6.00. In August, 1948, the Australian Branch of the Institute of Physics held a conference on heat transfer at Sidney. The material used at this conference has been expanded and presented by R. C. L. Bosworth in a volume published by an Australian firm. Dr. Bosworth writes clearly on a difficult subject. He even makes the Stefan-Boltzmann Law understandable and reasonably logical. Furthermore, the material is recent and deals in a practical way with the conduction of heat in gases, radiative transfer, conduction in solids and liquids, forced and natural convection, and heat flow with simultaneous phase change.

The volume is worth examining in that it will bring a technical library up to date on heat transfer phenomena. The principal objection to it is the low quality of the illustrations. Some charts are so poorly printed that they can scarcely be read, and reproduction of photographs are blurred and dull. Apparently, Australian printing is of poor quality if this is a representative example.

CONTROL OF ELECTRIC MOTORS, Third Edition, Paisley B. Harwood, John Wiley & Sons, Inc., 538 pages, $7.50. Harwood is Vice President in Charge of Engineering, Cutler-Hammer, Inc. and a Fellow, American Institute of Electrical Engineers. His book, *Control of Electric Motors,* is well known by engineering readers in its two previous editions. This third edition includes a great deal of new information on circuits, devices, and calculations used for the regulation of voltage, speed, and tension. It presents numerous industrial applications and gives clear and concise descriptions of electronic amplifiers, rotating regulators, and positioning servo-mechanisms. There is a new chapter on the basic principles of automatic regulating systems.

The edition, like the last, is arranged by motor types. It begins with a general discussion of wiring diagrams, construction details, and pilot devices as applied to all kinds of motors. It then moves into two sections, one on d-c motors and motor control and the other on a-c motors and their control.

ALSO AVAILABLE

MANUAL ON CUTTING OF METALS, American Society of Mechanical Engineers, $10.00. A new edition containing much new material on types, purposes, and application of cutting fluids; includes data on cost of cutting, idle and loading time, fuel changing, and grinding.

RECORDINGS OF THE FIRST U. S. NATIONAL CONGRESS OF APPLIED MECHANICS, American Society of Mechanical Engineers, 1000 pages, $20.00. This conference brought together most of the recognized authorities for a discussion of the most significant problems in modern applied mechanics. Their findings are presented in the 135 papers published in these proceedings.

GAS TURBINE PROGRESS REPORT, American Society of Mechanical Engineers, $1.50. Report surveys gas turbine applications in automotive, railroad, aviation, and marine fields, as well as in central stations. It reviews cooling methods, fuels, and performance of turbines and components.

INDUSTRIAL FILMS

"PORTRAIT OF AN ENTERPRISE," sound and color, 16 millimeter, 30 minutes. Dravo Corporation, Neville Island, Pittsburgh 25, Pa. Film shows scenes of heavy construction projects on river lots, dams, and bridges. Also shows methods used to produce and distribute river sand and gravel, and pictures construction of a central station power plant and a gas transmission line compressor station.

"COLOR COMES OF AGE," color film, 16 millimeter Martin-Senour Paint Co., 2520 South Quarry, Chicago, Ill., gives the views of architects, designers, color physicists, magazine editors, and other authorities on the importance of color to today's style of living.

FILM DIRECTORIES. The American Society of Mechanical Engineers and the American Materials Handling Society both publish a directory of industrial films available for group meetings. Headquarters of the American Society of Mechanical Engineers is 29 West 39th Street, New York; and the AMHS is located at 638 Phillips Ave., Toledo 12, Ohio.

RUST PREVENTION, color film, 16 millimeter, 30 minutes. Rust-Oleum Corp., Evanston, Ill. Shows the destructive effects of rust and explains preventative measures.

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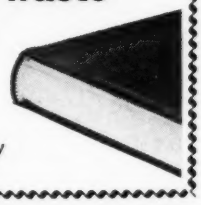

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